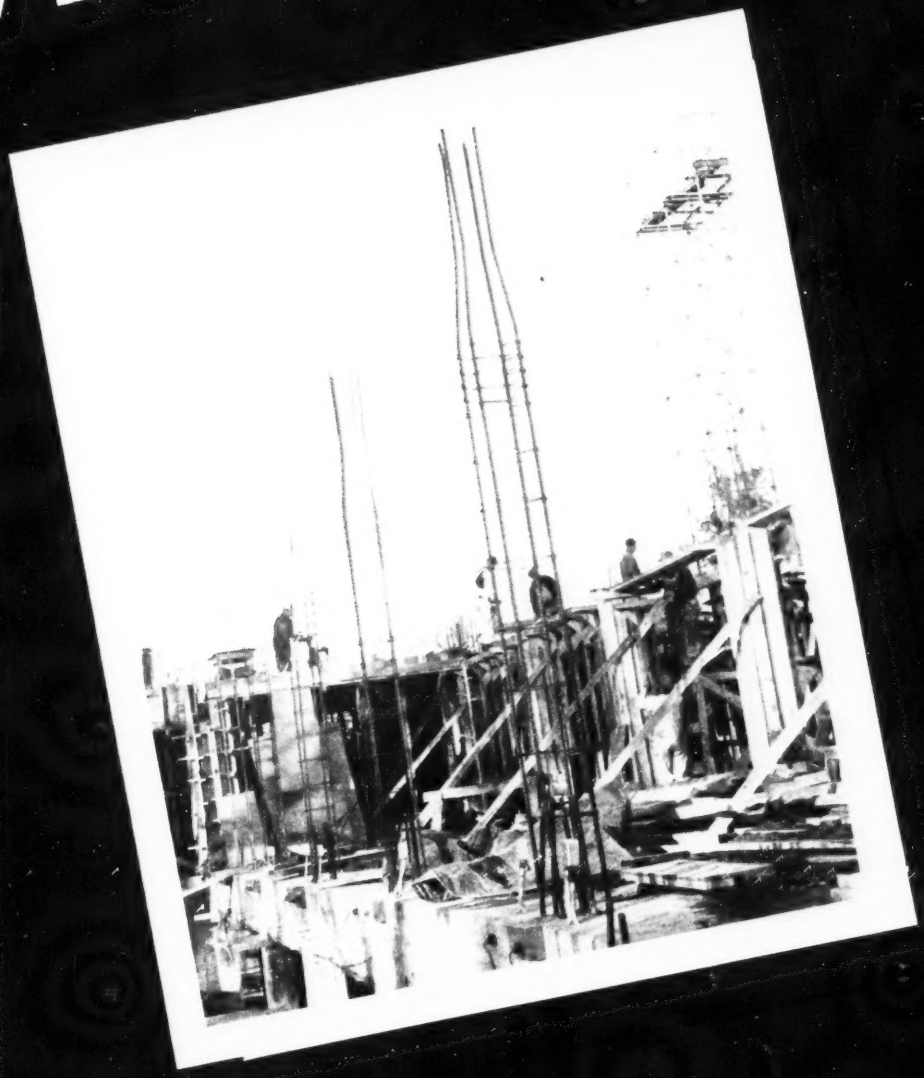
THE CORNELL ENGINEER



COLLEGE OF ENGINEERING · CORNELL UNIVERSITY

World's first Continuous Seamless Tube Mill

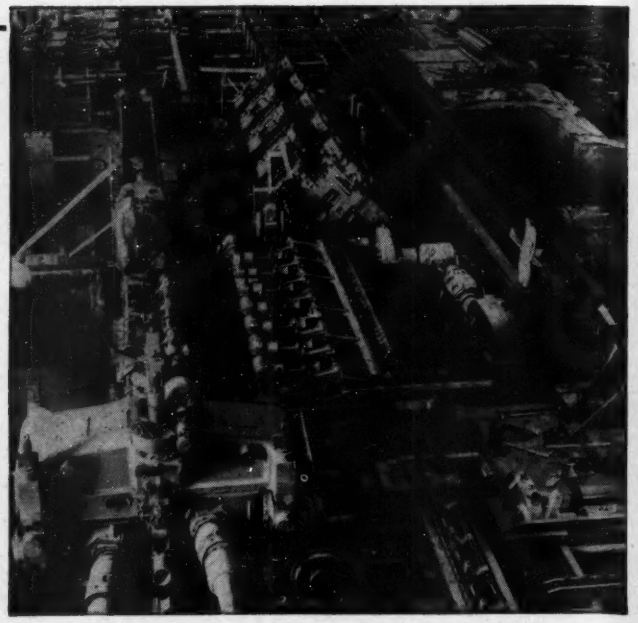
—National Tube Company develops revolutionary new mill design

2,000 feet of seamless pipe a minute! That's what the world's first continuous seamless pipe mill will turn out upon completion.

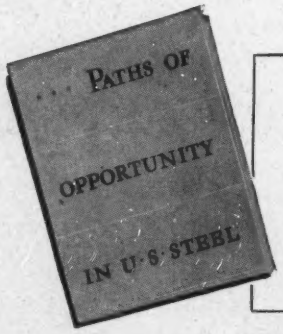
Developed by National Tube Company—U.S. Steel Subsidiary—at its Lorain, Ohio Works, the mill has already been referred to as "one of the greatest advances in the steel industry during the past 50 years."

The new continuous process it features will eliminate several steps in the conventional method of making seamless pipe and will be comparable to that of continuous strip and sheet mills. Designed to produce sizes ranging from 2 inches to 4½ inches OD, the mill not only will provide quality products at lower cost, but greater service to the consumer.

This revolutionary seamless mill design is another demonstration of National Tube Company's position of leadership in providing industry with both quality and quantity products.



Construction view showing 9-stand Rolling Mill and Inlet and Outlet Conveyors.



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CONTENTS

Scientific Approach to the Art of Dyeing 7
George L. Royer, Ph.D. '32

The Ethereal Medium 10
Kenneth M. Gellhaus, EE '49

Styrene Production — A Success In Planned Research 13
Jacques L. Zakin, ChemE '49

Concrete Tying Devices 15
Kenneth E. Bender, CE '49

News of the College 17

Profile — Carroll R. Harding 18
Nathan Ehrlich, EE '49

The Editor's Column 19

Prominent Engineers 20

Out of Phase 22
Herbert F. Spirer, EP '51

M.E. and E.E. Graduating Class of February, 1949 23

President's Message 24

Stress and Strain 44

Cover: Construction on Statler Hall, future home of the School of Hotel Administration, progressing at a rapid pace on a brisk December day.

—Fedkew

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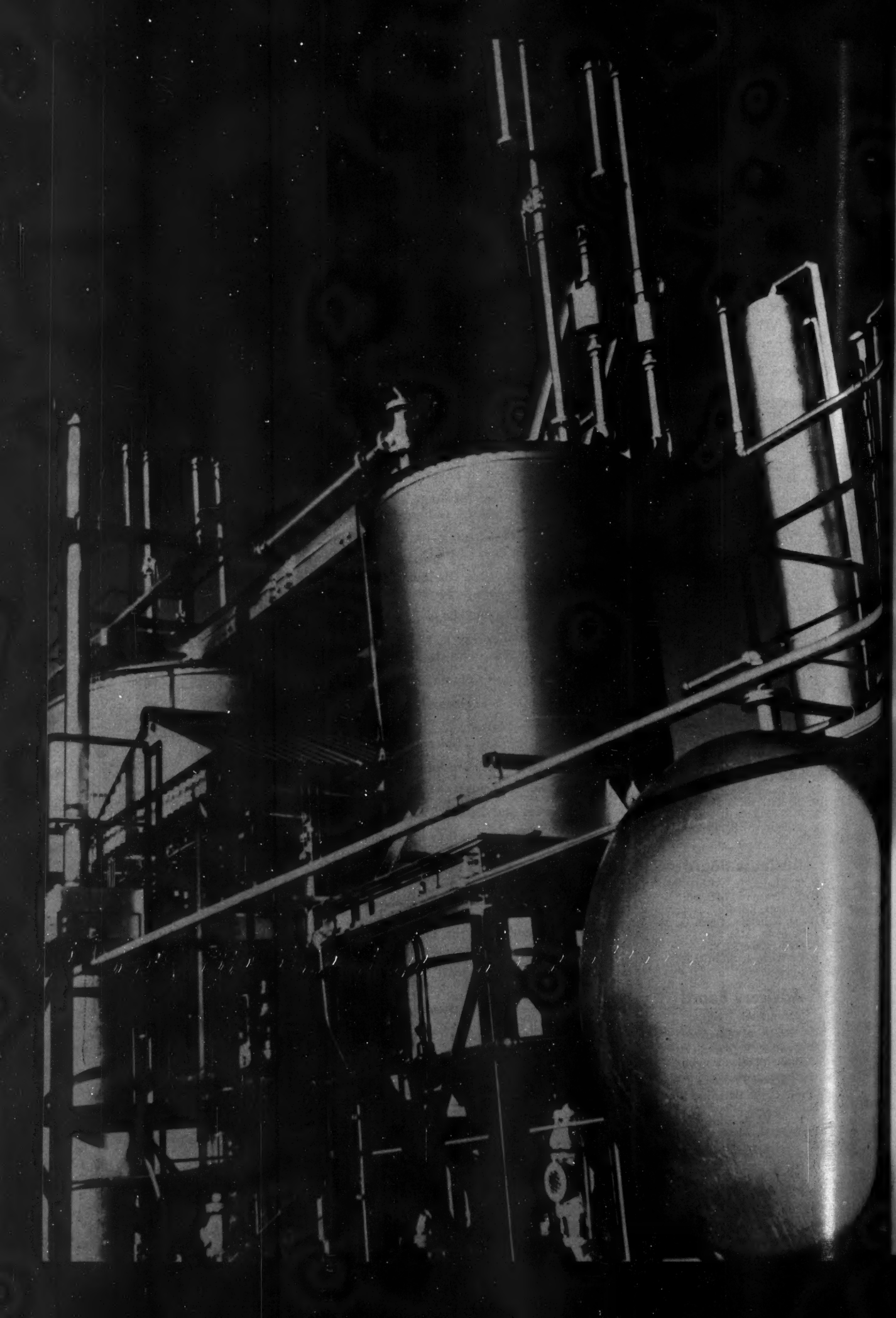


Scientific Approach to The Art of Dyeing

By GEORGE L. ROYER, Ph.D. '32

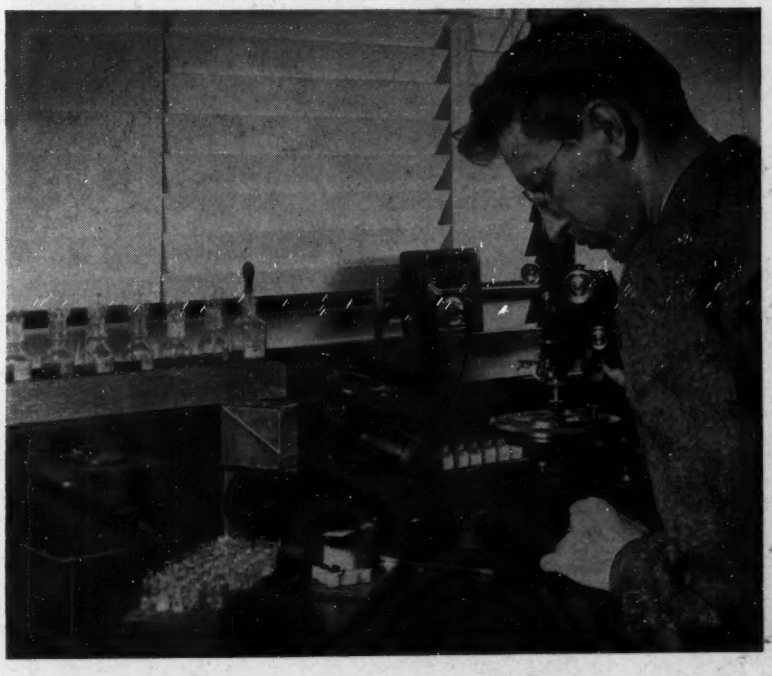
Photographs courtesy American Cyanamid Company

A MAN buying a suit of clothes or the woman buying a dress has little conception of the science entering the manufacture of the clothes long before they are displayed in the store. We hear about the basic industries, but since their products enter into the early stages of the manufacture of consumer goods, the public learns little about their contribution to the final article. Advertisements tell about the style and characteristics of textile materials, but little about the important contributions made by the many suppliers of the raw materials. Each of these suppliers is just as proud of his product and many times devotes much time and effort to a scientific study of his product so that it will give satisfactory service to the ultimate consumer. The chemical industry is one of these basic industries. Very few of their finished products are sold directly to the public, but the scientific research which has been done on its products has been a major factor in the success of many of the items which the public buys today.

An example of such research is that done by the dyestuff industry making possible the many products used in dyeing the colorful textiles of today. Going back to the textile material being bought in a clothing store, much of its appearance is contributed by the dye which produces its color. The importance of the proper application of the dye to give an appealing product does not enter the mind of the purchaser, but let the application be improper and immediately the results are evident. Color is evident, while other characteristics, such as tensile strength, abrasion, crease resistance, launderability, wearability, etc., cannot be judged so easily. For example, a fabric may be treated with a colorless resin for certain characteristics of finish, such as crease resistance, but because the resin is not visible, distribution on the cloth may not be important provided it produces satisfactory crease-proofing.

Dye, because it is so evident, must be carefully applied. Its application over the centuries has been, and is still an art. However, attempts are being made to apply science to the art in order to obtain a better understanding of the

Microscopical set-up for chemical and textile investigations. The fiber make-up of the textile material must be known, since there are no dyes which are applicable to all fibers.



Plant equipment used in the preparation of intermediates for the manufacture of dyes. Application of scientific research to the art of dyeing is making its possible to produce better dyeings at a lower cost.
—Courtesy American Cyanamid Co.

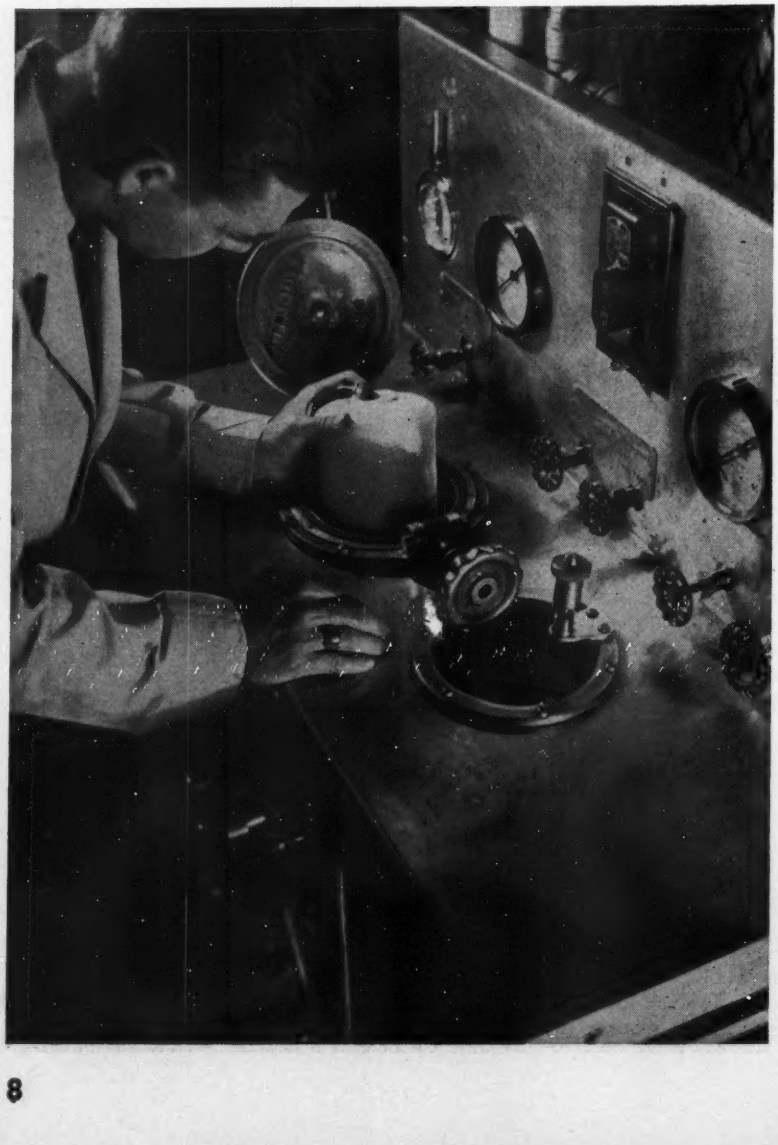
mechanism of dyeing so that better and cheaper methods of application can be used. The English chemists were first to recognize the importance of fundamental scientific data and now as a result of further study, both abroad and in this country, a much better explanation of the complex nature of dyeing has been obtained.

Microscope a Useful Tool

The microscope has been a useful tool in the scientific study of dyeing. Fiber morphology studies with the microscope are important from the point of view of the identification of textile fibers and for a study of the effect of fiber structure upon dye penetration and fixation. There are no dyes which are applicable to all fibers and it is necessary to know the fiber make-up of the textile material before it can be properly dyed. This is readily determined with the microscope by longitudinal and cross-sectional examination. The former is the most common method of viewing, but the latter offers many advantages in making the identification more positive because both the external shape and the internal structure are evident. Identification can also be aided by selective dye stains so that fibers in mixtures can be quickly picked out and the composition analyzed.

A microscopic study of the penetration of dyes and finishing agents into fabrics and the individual fibers themselves by cross-sectional examination can be correlated with properties such as color fastness, color strength, crease-proofing, and shrinkage control. The distribution of dye from fiber to fiber is important if the best color value and fastness are desired. Physical properties, such as tensile strength can be studied and correlated with fiber structure by observations under the polarizing microscope. Other microscopical tools, such as the electron and phase microscopes are also of value in special studies. Location of resins and other finishing agents can be studied microscopically and related to their use in creaseproofing and shrinkage control, proper distribution giving a different hand and better control. These research studies in which the microscope is an effective tool are helping to develop new products and new uses of old products. These are also showing us how and why certain products function. This information will serve to make improved products which in the end will mean better consumer satisfaction.

A dye chemist operating a laboratory package dyeing machine. This laboratory equipment reproduces results of much larger plant equipment in carrying out one of the more modern methods of applying dyes.



Uniform Dyeing

One major problem in the practical application of dye is the uniform distribution of dye on all parts of the piece of cloth. In the laboratory this is rather easy to control because both the volume of the dye bath and the quantity of material being dyed is small and therefore uniform agitation is easily obtained. The handling of large quantities brings in engineering problems which have resulted in many different designs in dyeing equipment. In nearly all cases these require rather slow removal of the dye from the bath to aid in obtaining uniform distribution. From this it is evident that data on the rate of removal of a dye, or the *rate of exhaustion* of a dye, as the dyer calls it, are important information for successful dyeing. The rate of exhaustion of a dye will vary over a wide range depending upon the dye itself and the conditions under which it is applied, i.e. temperature, pH, salt concentration, etc.

The dyer has learned many of the characteristics of dyes from experience. The scientific approach has been to study the exhaustion of

View of a Dyeometer in place in a recording spectrophotometer. This instrument allows one to study the exhaustion of dyes under known controlled conditions of temperature, stirring, chemical additions, etc.

dyes under known controlled conditions in order to define better the effect of the variables so that controls can be used with an improved understanding of what is happening. An instrument called the *Dyeometer* has been designed to obtain these scientific data. It is a laboratory dye bath in which temperature, circulation, stirring, volume, and chemical additions can be controlled at will. It is placed into a recording spectrophotometer, an instrument for accurately measuring color concentration, in order that the dye content of the dyeing bath can be recorded throughout the dyeing operation. From the data obtained from this equipment it is possible to draw graphs which illustrate the amount of dye exhausted at time intervals during dyeing under certain established conditions. Figure 1 (page 30) shows examples of exhaustion curves obtained from the study of the effect of salt addition in cotton dyeing. Less than 20% dyeing takes place with no salt, but with 20% salt the dyeing is very rapid. The suggested addition of salt for control is shown in the third curve. These data can be correlated with plant conditions and thus be of value in the practical application of the many dyes that are used.

The dyeing art would not be so complicated were it not for the many dyes available. The large number (more than 1000 are listed in "The Colour Index") are manufactured because each has its special property which makes it applicable to a specific situation. For example, many dyes for wool can be applied easily with good uniform distribution. However, their fastness to washing is often poor. Those having good wash fastness are often difficult to apply. In some cases wash fastness is not an important factor and then these easier-to-apply dyes can serve. The choice of the proper dye depends mainly upon the use of the product, and the dye which has the properties for this use will serve best. The scientific dyeing data will make these properties, particularly those relating to application, more obvious and thus promote easier and better dyeing methods.

In addition to the possibility of studying the differences between dyes, it is possible to take one dye and use it for a study of differences in textile fibers. Wool differs greatly due to natural causes during its growth on the sheep and is modified by various cleaning treatments during processing. Cotton also varies due to conditions of growth and chemical treatments, such as bleaching and mercerization. Rayon, being a synthetic fiber, varies due to conditions used in its manufacture and a study of the variation in these conditions makes possible the development of better rayon fibers. In most cases the takeup of a dye can be related to both the physical and chemical properties of the fibers. Better conditons of treatment to retain the proper chemical and physical properties can be developed which will result in textile fibers with superior properties.

Fiber Tensile Properties

Another approach in the scientific study of dyeing has been an investigation of the effect that various chemical treatments have upon the tensile properties of the individual single fibers prior to, during and after dyeing. Most physical properties of textiles are determined on fabrics or threads, in which case the effect obtained depends to some extent on the relationship of one fiber to another. For example, the twist, weave, and number of fibers greatly affect the textile strength.

(*Continued on page* 30)

THE AUTHOR

George L. Royer

George L. Royer is Assistant Director of the Physico Chemical Section of the Research Department for Calco Division of the American Cyanamid Company, Bound Brook, New Jersey. He attended Akron University, receiving a B.S. degree in chemistry in 1929. He studied optical chemistry at Cornell and received his Ph.D. here in 1932. Mr. Royer has specialized in chemical microscopy, microchemistry, spectrophotometry and various phases of physical chemistry, particularly relative to dye application. In 1947, he was invited to England by the Society of Dyers and Colourists to present some of the work being done in the Calco Laboratories.

Mr. Royer has been active in the affairs of the American Chemical Society, having been Secretary-Treasurer of the Division of Analytical and Microchemistry for several years during the time of its formation, and was later elected its Chairman.

2,300-YEAR OLD RIDDLE REMAINS INCONCLUSIVELY SOLVED

The Ethereal Medium

By KENNETH M. GELLHAUS, EE '49

. . . All the phenomena of the physical universe are only different manifestations of the various modes of motion of one all-pervading substance—the ether.

—A. A. MICHELSON

JAMES MAXWELL has gone down in history as the "discoverer," just eighty years ago, of the ether, described as "an imponderable, electric medium supposed to pervade all space as well as the interior of solid bodies; the invisible, odorless, tasteless substance assumed to exist, through which light, heat, and radio waves are transmitted."

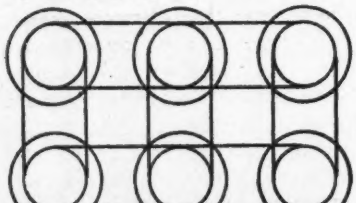


Fig. 1, Fitzgerald's Ether Model. The wheels, separated from one another by a small distance, are geared together by elastic bands. Mention of positive and negative electricity as separate entities was avoided, since all wheels turn in the same direction. (From Lodge's *Modern Views of Electricity*, 1889.)

In 1931, the hundredth aniversary of his birth, Maxwell's ether theory was called "a triumph of the scientific imagination" which, as convenient fiction, helped physicist and layman to bridge a mysterious gap, closed when the world realized that wireless waves are electromagnetic, not "ether."

Insistence upon a *form* of this ether is the only alternative to acceptance of the principle of action at a distance. Thus, the question of the existence of a form of ether is yet some time from being closed with an emphatic and unanimous "No" from all scientific quarters, as shall be seen from the necessarily brief summarizations of ethereal history and contemporary thoughts which follow.

Pondered by Greeks

The Greeks answered the query, "How does light get to us from the sun and stars through interstellar space," very simply and satisfactorily—to themselves, at any rate. They said that the sun and all radiators of light and heat must shoot off minute corpuscles whose impact upon the eye or skin produces the sensations of light and warmth.

This corpuscular theory was the generally accepted one up to 1800. It was chcallenged, it is true, about 1680 by the Dutch physicist Huygens, who argued that light might be some vibratory disturbance transmitted by a medium which fills all interstellar space. He postulated the existence of such a medium, which was called the luminiferous or lightbearing ether.

Partly, no doubt, because of Newton's espousal of the corpuscular theory, the ether or wave theory gained few adherents until some facts of interference began to appear about 1800 which baffled explanation from the standpoint of the corpuscular theory, but which were easily handled by its rival. During the nineteenth century the evidence became stronger and stronger, until by its close the corpuscular theory had been completely eliminated.

Oliver Lodge, a great English physicist and thinker, in 1889 wrote a small volume titled "Modern Views of Electricity" in which he compared the ether, of which he was one of the most persuasive and lucid interpreters, to an elastic jelly filling all space; he compared magnetism to whirlpools in that jelly,

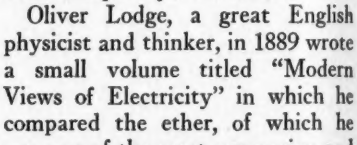
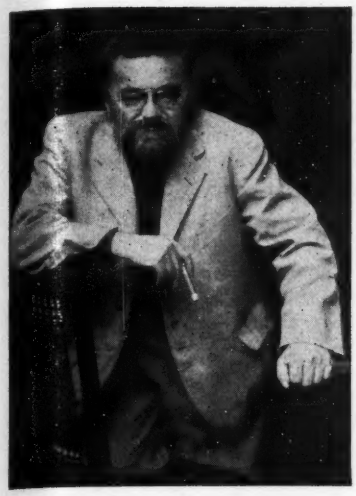


Fig. 2. Hydrogen atom and associated ether currents. Proponents of the ether vortex theory say that it seems probable that the direct axial or polar flow of ether is from proton to electron. (From Krafft's *Ether and Matter*, 1945.)

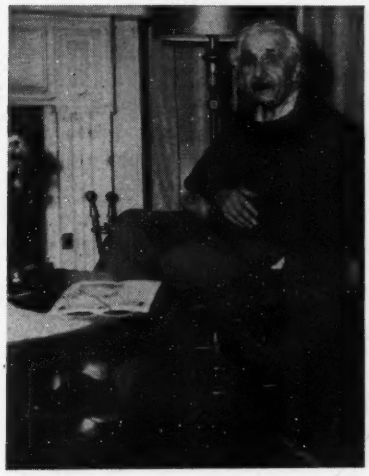
or, more crudely, to interlocking wheels. To him the universe was a gigantic machine.

Prof. Fitzgerald, of Dublin, devised a model (Fig. 1) of the ether, which by help of a little imagination "represents the two kinds of displacement—the electric and magnetic—very simply and clearly," according to Lodge.

The ethereal concept has been ridiculed, virtually demolished, and staunchly supported, respectively, by this famous scientific trio.



Charles P. Steinmetz said that electrical engineers have dealt successfully with alternating voltage and current waves with never a need for an ethereal carrier of the electric wave.
—Courtesy General Electric Co.



Prof. Albert Einstein, presently associated with the Institute for Advanced Studies at Princeton, New Jersey, whose generally accepted theory of relativity contradicts the existence of an ether.
—Clearose Studio

Prof. Albert A. Michelson, head of the University of Chicago's physics department from 1892 to 1929, was a staunch believer in an ethereal medium and hoped that the relative theory might be reconciled with existence of an ether.
—Courtesy University of Chicago

Fitzgerald's wheels are separated from one another by a certain space, and are geared together by elastic bands. They thus turn all in one direction, so avoiding mention of positive and negative electricity as separate entities. A row of wheels corresponded to a section of a wavefront.

Lodge himself proposed to contemplate a double series of wheels geared directly into one another, and representing positive and negative electricity because it seemed to him that so many facts pointed to the existence of these two entities. Light, then, consisted to him of undulation or waves in the medium; while electricity, he felt, might turn out to be an aspect of a part of the very medium itself.

Another of Lodge's suggestions was that positive and negative electricity together may make up the ether, or that the ether may be sheared by electromotive forces into positive and negative electricity.

The Ethron Conception

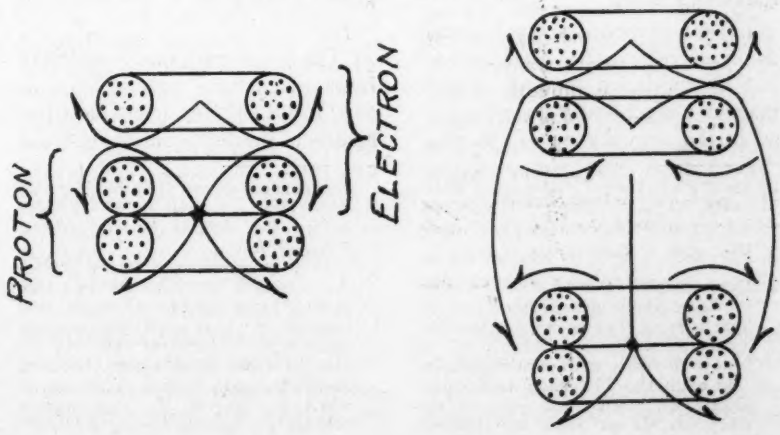
That the ether is composed of identical tiny spherical shells like bubbles ("ethrons") which are made individually rigid by impulses of an almost infinite frequency is yet another conception. These ethrons are calculated to occupy almost exactly 74 percent of all space, all matter being located in the 26 percent of space between the ethrons The diameter is calculated at about 2.82 angstrom units; i.e., over 90 million ethrons per lineal inch. Gravitation, radiation, heat, chemical action, volcanoes, fissures of the earth's crust, and clairvoyance are freely attributed to this ether. Further, all existing matter supposedly has been generated from and by this ether, and is now being generated, from "dead" ethrons.

Ether Vortex Theory

There are those ether adherents who assume that electrons consist of a vortex in a hydromechanical ether of "quasifrictional" properties (idealized viscosity), Hermann Fricke of Germany having been its leading exponent. This *ether vortex theory* teaches that protons and electrons keep the ether in continuous circulation between them as shown in Figure 2.

The neutron shown in Figure 3 has the same mass as the proton. This diagram also illustrates why

Fig. 3. A neutron at left and a hydrogen atom at right with their associated ether currents as visualized under the ether vortex theory.



Dr. Robert A. Millikan states in *Electrons* (+ *and* —) *Protons*, etc., a volume which grew immediately from the Messenger Lectures he delivered at Cornell, that the relativity theory has no bearing upon the question of the existence of an ether in his use of the term. Dr. Millikan is presently Vice-President of the Board of Trustees and Professor of Physics, Emeritus, at California Institute of Technology.

—courtesy Calif. Inst. Tech.

the electron cannot fall into the proton, the reason being that upon close approach the surfaces of these two particles will rub each other in opposite directions as noted by the short curved arrows.

In partial support of this theory it is stated that quantum mechanics does not require the existence of an atomic nucleus as distinguished from the structural center, or center of inertia, of the vortex atom.

Maxwell's Work

Light was identified by Maxwell as an electromagnetic phenomenon, but he concluded that all electromagnetic effects must be propagated in the optical ether. (The phenomenon of polarization shows that light is a transverse wave.) Instead of abandoning the optical ether as unnecessary he elevated it to the most fundamental role in electromagnetic theory. Indeed, electromagnetism following Maxwell became a mechanical theory of the state of an elastic medium.

Underlying Maxwell's work in representing the propagation of light by differential equations was the Faraday conception of electric tubes representing stresses in an all-pervading ether. The same differential equation, the Helmholtz equation, is closely related to quantities that have direct mechanical analogues; that is, stresses and strains in an elastic medium. It is then entirely natural to transfer the entire terminology belonging to the stress and strain model to the corresponding electrodynamical symbols.

Ronold King, in his recent "Electromagnetic Engineering" employs this analogy in a reductio ad absurdum saying that, "It can be argued that it is manifestly absurd to speak of stresses in sheer emptiness, so that one is 'compelled' to assume that all space is filled with a strange medium that has both the properties of an elastic solid like steel and those of a vacuum.

"A correspondence between the mathematical properties of two physically unrelated functions does not require, or even make it likely, that a model that is sensible for one function will be correspondingly sensible for the other."

King thus takes a point of view which denies the necessity of providing a physical analogue for every symbol in a mathematical model.

"The era of mechanical models of electromagnetic phenomena is past;" says he, "the age of electrical models of matter is unfolding," and even these models will eventually become obsolete.

Opposed by Relativity Theory

By 1900, then, the ether theory had become apparently impregnably entrenched. A couple of years later it met with considerable opposition from advocates of Einstein's relativity theory.

In a book which grew immediately out of a lecture series which he gave at Cornell, physicist Robert Millikan states that the relativity theory has no bearing upon the question of the existence or nonexistence of an ether in his use of the term.

Most ether proponents,[1] however, have actually sought to disprove relativity's postulates, and it must be admitted that the evidence[2] which they have amassed toward discrediting the theory is considerable, notwithstanding the apparent absurdity of many of their proposed ether forms.

Maxwell deduced mathematically, and Hertz demonstrated experimentally, that light is an electromagnetic wave—that is, an alternating electromagnetic field of extremely high frequency. Millikan's ether was called into being solely for the sake of furnishing a carrier for these electromagnetic waves, and so defined it stands or falls with the existence of such waves in vacuo, and this, he reminds us, has never been questioned by anyone.

A wave may be a wave motion of matter, as the water wave and sound wave, or it may not be a wave *motion*. "Electrical engineering," stated Charles Steinmetz, G.E.'s electrical wizard, just a year before his death, "has dealt with alternating current and voltage waves, calculated their phenomena and applied them industrially, but has never considered that anything material moves in the alternating wave and has never felt the need of an ether as the hypothetical carrier of the electric wave."

Ether Drift Tests

Throughout the nineteenth century, both before and after the advent of the electromagnetic theory, it was natural that scientists should be concerned with questions

(*Concluded on page* 36)

1. See *A Philosophical Appraisal of Relativity*, Theodore Stalzer, 1932; *New Theory of the Aether*, Dr. T. J. J. See; etc.

2. One example is that of the Einsteinian prevision of the deflection of rays of light passing close to the sun, the disagreement being considerable for a theory of purely mathematical origin.
   In addition, "The actual stellar displacements, when freed from all assumptions, do not show the slightest resemblance to the predicted Einstein deflections . . ."—Prof. C. L. Poor before the Optical Society, Ithaca, N.Y., 1929.
   In a communication to the British Association in 1921, Sir Oliver Lodge said: "Especially do I attack that proposition which asserts that to every observer the velocity of light will not only be constant in reality, but will also superficially appear constant even when he ignores his own motion through the light-conveying medium."

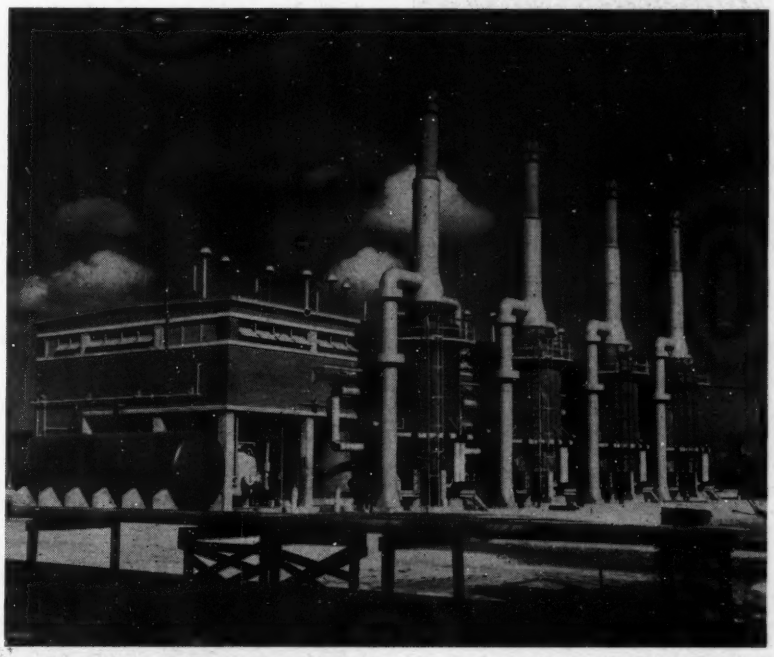
FIRST STEP IN
BUNA-S MANUFACTURE

Styrene Production---
A Success in Planned Research

By JACQUES L. ZAKIN, ChemE '49

WITH the sources of our natural rubber supply threatened before the last war, a large-scale supply of synthetic rubber became not merely a project for the future but an immediate necessity. Styrene copolymerized with butadiene, and with small amounts of filler present, gives Buna-S rubber which is suitable as a substitute for natural rubber. But the prewar production of styrene was a small trickle compared to that required for the wartime rubber program. A program for large-scale styrene production had to be, and was, devised.

When research on the manufacture of styrene was begun in the early thirties, the process was broken down into three separate steps, each with its own special problems, all of which had to be solved before commercial production could begin. The steps were: first the formation of ethylbenzene, second the reaction of ethylbenzene to form styrene, and third the ticklish problem of purifying the readily-polymerizeable styrene.



One of four ethylbenzene cracking units of the styrene plant of the Dow Chemical Company. Here ethylbenzene is converted into crude styrene by dehydrogenation. —*Courtesy Dow Chemical Co.*

Ethylbenzene Production

Ethylbenzene could be produced in a number of ways: (1) from benzene and ethyl chloride, (2) by the reaction of benzene and 95 percent ethyl alcohol as vapors in the presence of phosphoric acid, (3) by combining vaporized benzene and ethylene in the presence of phosphoric acid, (4) or by a modified Friedel-Crafts reaction in which liquid benzene and ethylene are reacted in the presence of an aluminum chloride catalyst and hydrogen chloride. The last method is most common as the operating pressure need not be raised, small amounts of sulfur impurities are tolerable, lower concentrations of benzene will give satisfactory yields, a clearer polystyrene product is formed and no recycling of the ethylbenzene product is necessary.

The quantity of polyethyls produced from benzene and ethylene in an equilibrium system is 31 percent of the product. In commercial production this is cut down by reducing the ratio of ethyl groups to benzene rings and by separating and recycling the polyethyls.

To prevent water from poisoning the aluminum chloride catalyst, the benzene feed is passed through an azeotropic drying column. The dehydrated benzene and ethylene are fed to a tall cylindrical chamber where the reaction takes place:

$$C_2H_2 + C_6H_6 + \text{catalyst} = C_6H_5C_2H_5$$

The reaction mechanism involves a complex of aluminum chloride and hydrocarbons which forms a separate layer. The reaction products are cooled and passed to a separator where the aluminum complex settles out and is recycled. The ethylbenzene is sent to a caustic scrubber and then to another separator where any entrained impurities are allowed to settle out.

The crude ethylbenzene is fed to a stripping column. Benzene is taken off at the top and mixed with the feed. Ethylbenzene, polyethyls and

The interior of the distillation control house of the Monsanto styrene plant at Texas City. This picture is of the old plant which was destroyed April 16, 1947, when the ammonium nitrate-loaded S.S. Grandcamp exploded at a dock adjacent to the plant.
—Courtesy Monsanto Chemical Co.

other higher-boiling hydrocarbons are taken off at the bottom and are purified in a vacuum still. The polyethyls may then be recycled. The purified ethylbenzene is rewashed with sodium hydroxide, dried over a bed of caustic flake and is ready for the second step.

Two Methods of Synthesis

In the early stages of the research work on the synthesis of styrene, two methods of seemingly equal potentialities were available. The first approach was through the chlorination of ethylbenzene. Unfortunately, the chlorine substituted in both the α and β positions and the former had to be removed. The β-substituted compound was hydrolyzed to give β-phenyl ethyl alcohol which was then dehydrated with alkali to give a relatively pure styrene product. This method had the inherent fault of giving an intermediate with a high percentage of the unusable α-substituted compound. Before styrene could be produced on any substantial scale at a reasonable cost, the overall yield had to be increased. The alternative involved the catalytic dehydrogenation of ethylbenzene. This reaction took place at a fairly high temperature and did not give as pure a product as the other.

With the two processes having equal possibilities, a difficult choice had to be made to decide on which to concentrate. The decision was one based on practical considerations. In the event of an emergency, the supply of chlorine would be taxed by increased demands from many quarters. To forestall any tie-ups on this count, the second reaction was chosen although research on the first was not dropped altogether. Subsequent developments have shown that catalytic dehydrogenation was the better choice, not only for the reason given, but also on the basis of overall economy.

In the continuous catalytic dehydrogenation process, a mixture of superheated steam and ethylbenzene are first sent to a superheater where they are heated to a temperature of more than 1300°F. and then to the reaction chamber where more steam is added. The steam serves to keep the partial pressures of the other constituents low, thus favoring the dehydrogenation reaction, and also supplies heat for the endothermic reaction. The ethylbenzene breaks down to form styrene and hydrogen:

$$C_6H_5C_2H_5 = C_6H_5C_2H_3 + H_2$$

The catalyst may be a mixture of aluminum and other oxides. Theoretical conversion is about 70-80 percent and an actual conversion of almost 40 percent per pass is achieved.

The reaction products are made up of styrene, ethylbenzene, hydrogen, benzene, toluene, tars and steam. They are partially cooled to condense and remove the tars. Further cooling condenses the main products and water is removed in a series of separators giving a crude styrene which is ready for the final step of purification.

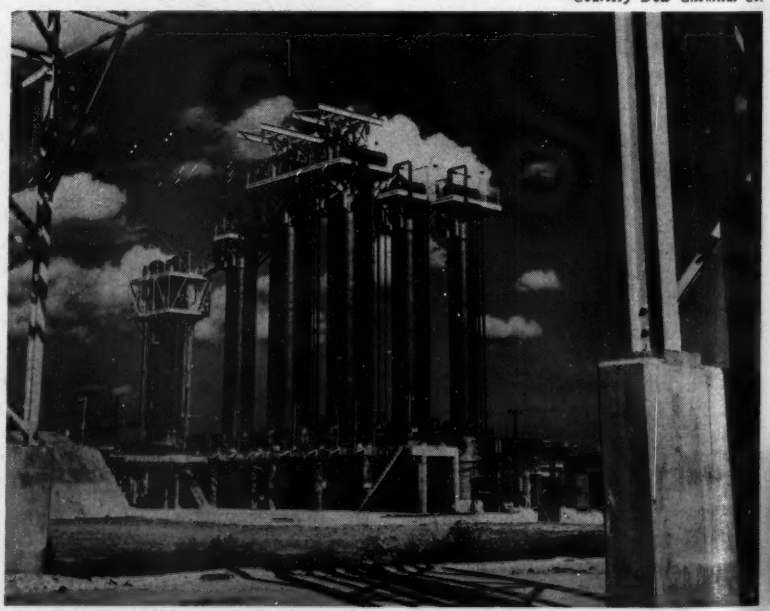
Styrene Purification

The purification of crude styrene is acomplished by a series of fractionations. The polymerization rate of concentrated styrene becomes appreciable above 195°F. which is 100 degrees below its normal boiling point. A great deal of special care must be taken to keep temperatures below this figure and utilize polymerization inhibitors. A tower full of solid polystyrene is the favorite nightmare of the operating engineers of any styrene plant. Sulfur, which acts as a polymerization inhibitor, is generally added to the crude styrene at the start of the purification.

The first stage in purification is separation of benzene and toluene from the main stream. These may in turn be separated and purified as by-products. The stream of ethylbenzene and styrene is fed to

(*Concluded on page 28*)

Specially designed fractionating column for separating crude styrene into its individual components at the Dow plant at Velasco, Texas. The original capacity of the plant was 50,000 tons a year, but it will produce 75,000 tons a year.
—Courtesy Dow Chemical Co.



LARGE SCALE CONCRETE USE
DICTATES COMPARABLE BRACING

Concrete Tying Devices

By KENNETH E. BENDER, CE '49

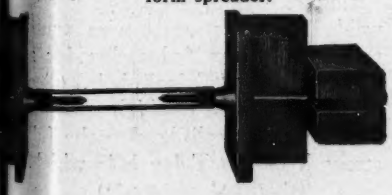
Diagrams courtesy Richmond Screw Anchor Company

IN ORDER to obtain a clear and comprehensive view of the field that encompasses concrete forms and tying devices it is necessary to retrogress to the days of the Roman Empire. During this period a great deal of construction work was undertaken by the Romans who led the world in feats of engineering construction, as well as socially and academically.

We owe a great deal to these ancient peoples for they indirectly made possible many of today's magnificent structures such as the Hoover Dam, the Pentagon Building, and our beautiful highways. The Romans are responsible for these structures because they first discovered natural cement and employed it to advance civilization.

How natural cement was first employed is not too clearly known, but it may be safely assumed that they used a mix of stiff consistency. Inasmuch as they lacked the necessary mechanical equipment this stiff mix was applied by hand gradually until the desired shape was attained. Naturally, they were limited in the amount and scope of the work that they were capable of doing, but remaining to this day as tangible evidences of their efforts are many foundations and structures.

Fig. 2. The Tyscru used as a tie and form spreader.



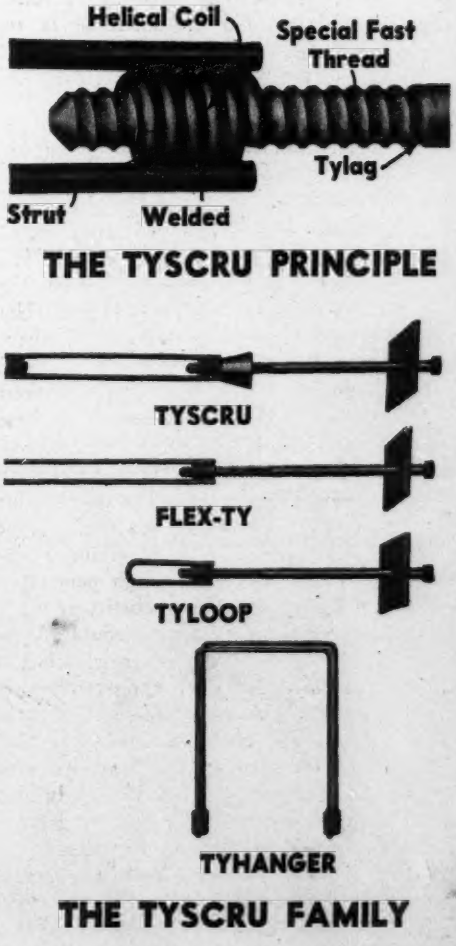
About 1824 an Englishman named Aspdin discovered Portland cement, thus marking the beginning of a new era in the field of construction. As time progressed, more and more engineers heard of this new material and they began to apply it to heavy foundations for static structures. The result of these early efforts created an entirely new branch of construction, and thus concrete was developed.

Concrete Made Debut in 1875

Concrete made its debut in the United States about 1875, but its use as a structural material did not become wide spread until the early 1900's. The Turner Construction Company of New York City was one of the early proponents of this revolutionary material, and it was largely through the efforts of this company that great strides were made in the use of reinforced concrete.

Concrete forms as we know them today did not exist until after the advent of Portland Cement and concrete. Prior to this time all masonry work was of such a diminutive nature that the forms were easily braced to the ground or some other structure. As the standard of living rose, the need for larger and more comfortable structures became quite apparent. As the structures increased in size and weight, larger sizes of lumber were necessary for bracing, which increased the cost of the job. In addition to this, the braces lost a large percentage of

Fig. 1. The Tyscru Principle and several adaptations.



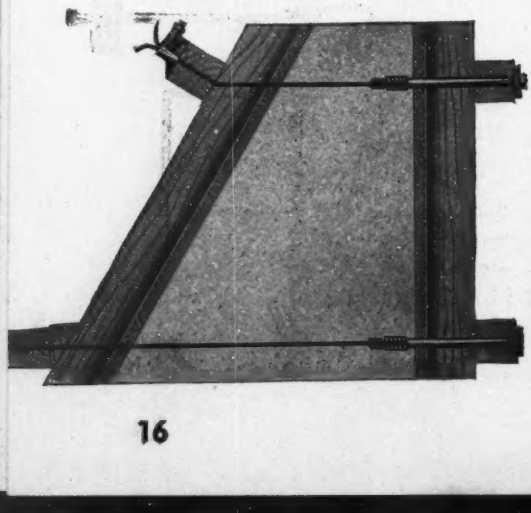
their efficiency as a result of the extreme angles at which they had to be placed.

No Change in Basic Forms

The forms in themselves have not changed through the years from the basic system of using sheathing, wales, and studs, but the method of holding them together has undergone a radical transition. When concrete is poured into a form six feet high a pressure of 900 pounds per square foot is exerted against the form at the base. As the size of the forms grew, and larger pours were used, it became evident that bracing was no longer satisfactory. Some other means of holding the forms together had to be devised in lieu of this heavy and expensive bracing. The first step in rectifying this condition was the use of heavy wire and cable which provided adequate strength.

This heavy wire was strung from wale to wale or from stud to stud until the desired strength was attained. In order to eliminate the slack that was invariably present, a piece of wood was inserted between the strands and twisted—the entire affair being analogous to a turnbuckle. One of the disadvantages of this system was an unequal stress which resulted in a warped form. In addition to this, some arrangement for removing the wire had to be provided when the forms were being stripped. The general method of accomplishing this was to cut the wire with a pair of heavy shears at the face of the concrete, but this caused subsequent rust spots that were detrimental to the beauty and finish of the completed structure.

Fig. 4. Installation of the Flex-Ty.



In an attempt to alleviate the unequal distribution of stress caused by the wire and rid the nuisance of warped forms, straight steel bands were introduced. These steel bands, about 2 inches wide and 1/8 inch thick, were inserted between the planks of the sheathing and clamped on the outside face of the forms. Although the steel bands were easier to install and handle, they still did not perform as well as they might, for these too presented the problem of rust spots on the finished surface.

Following steel bands, the next innovation to appear were steel bolts with square heads and machine threads. Structurally speaking, these bolts were strong enough to serve the purpose for which they were intended; however, the rust problem had not been eliminated. In addition to the rust, another problem had presented itself because the bolts could not be cut close to the surface with shears. The only feasible solution was to chip out the concrete and try to knock off the end of the bolt, but this, in addition to being costly, was not practical due to the rather large holes that remained which had to be grouted.

Rod and Rod Clamp Developed

The next step in the development of tying devices was a rod and rod clamp which was about equal in performance to the bolts and steel bands. With all of these arrangements the effect of unequal stress distribution was still prevalent due to the human element that was unpredictable. The rods had an advantage, however, in the fact that they could be removed from the forms even though the procedure was rather difficult. The removal of the rods was made possible by an arrangement that consisted of two rods with threads on both ends and a steel sleeve that was threaded on the inside. The sleeve was placed between the forms, and the rods were threaded into the sleeve through holes from the outside. The clamps were outside of all of the form lumber, and in stripping, these were removed first. The rods were then screwed out of the sleeve leaving only a small hole to be grouted. By use of this system it was possible to eliminate the rust that had been so troublesome with the other types of ties. As an added feature an unthreaded cone was used in conjunction with these rods to spread the forms apart and aid in retaining the true form.

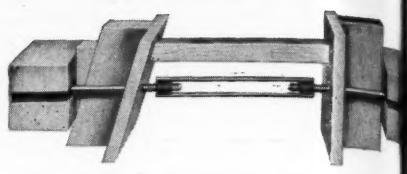


Fig. 3. The Tyscru adapted to battered walls.

"She-Bolts" Make Appearance

Later, after a rod and rod clamp device had been developed, a variation appeared, called "She-Bolts," which many contractors resorted to because they could be manufactured in their own shops, thereby reducing the cost of the forms. The "She-Bolt" was the outside member of the tie, and it was so constructed as to be tapered on the inside end and to have an inside thread. The manner of assembling them was the same as that of the rods and clamps. The addition of the tapered end was to expedite the removal from the forms when the concrete had achieved its initial set. An advantage of this system was that, by permitting easy removal, a good clean exterior finish was provided. Also the contractor was able to use the "She-Bolts" and outside clamps many times, thereby reducing the cost of the job.

In the late 1920's, there appeared on the market a product which embraced all of the essential features of a perfect concrete tying device: simplicity and flexibility. This device, called the *Tyscru,* along with the rest of the Tyscru family, is produced by the Richmond Screw Anchor Company of Brooklyn, New York.

The Tyscru family of products is based on a simple principle consisting of the use of a helix coil welded to high strength wire struts to act as a threaded socket for a coarse thread "Tylag" bolt. (See Fig. 1). In action the high strength wire and helix coil develop the full strength of the Tylag bolt which,

(*Continued on page* 34)

News of the College

Materials Dept. Consolidate

Parallel departments in the Mechanical and Civil Engineering Schools have been consolidated into a new department of Engineering Materials. The Departments concerned were established at the opening of the University in 1868. Dr. D. F. Gunder, Professor of Mechanics in the College of Engineering, was named acting head of the new department.

Dean S. C. Hollister of the College of Engineering said the consolidation will permit closer coordination of instruction and more effective use of the elaborate equipment used in the materials field. A considerable amount of this equipment will be made available in the materials and metallurgy laboratory, which is part of the building program projected in the long-range development program of the College of Engineering. At present, the new department will occupy various laboratories in the Colleges of Civil and Mechanical Engineering.

Light Gage Steel Research

Exact design specifications on light gage steel have been one of the primary needs of the American building industry for many years. Beginning in 1940, under the sponsorship of the American Iron and Steel Institute, a research program was undertaken at Cornell to establish the nature and distribution of stresses in some 800 light gage steel specimens, most of which were one-sixteenth of an inch or less in thickness.

These tests have resulted in the "Specifications for the Design of Light Gage Structural Members," issued by the Steel Institute, which by this time have been incorporated into the local building codes of a great number of municipalities.

Dr. George Winter of the School of Civil Engineering has had charge of the testing program at Cornell for the past nine years. At the Third Congress of the International Association for Bridge and Structural Engineering in Leige, Belgium, September 13-18, 1948, a paper by Dr. Winter was delivered. It was titled "Performance of Thin Steel Compression Flanges," and presented results of the tests he has carried on at Cornell.

In a future issue, the CORNELL ENGINEER will print an article by Dr. Winter on these tests which are expected to revolutionize present design practices in the use of thin gage steel.

Elections

Tau Beta Pi

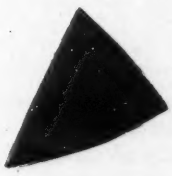
The following new members were elected to Tau Beta Pi at a meeting on November 18th:

Leonard G. Abraham Jr.
J. Perry Barger
John E. Barnes Jr.
William Newton Brown
John C. Colman
Horace F. Corning
David L. Cownie Jr.
Thomas J. Elder
William R. Elmendorf
Daniel E. Emerson Jr.
John N. Eustis
Bruce C. Graham
Carl P. Irwin
Frederick A. Jessen Jr.
Carl B. Johansen
Howard Kaltbaum
Wendel F. Kent
David W. Kennedy
George Albert King
William W. Langhorst
Rocco C. Lapenta
Edward Eugene Lewis
Daniel D. Mickey
Kenneth W. Moore
Michael E. Pearson
Gilbert E. Pinkham
Walter J. Plate
Thomas M. Potts
Donald C. Roberson
Spencer M. Robinson
Louis Skoler
John C. Snedecker
John Dirck Ten Hagen
Richard L. Wanner
N. Austin Weston

Chi Epsilon

The following are this term's new initiates:

Jules Bigio
Charles Weidner Deakyne
Thomas James Elder
George Neil Freeman
Robert William Gilfillan
Thomas Phillip Hollowell
George Albert King
Russell Jay Kuhn
David S. Morgan
Arnold Stanley Nelson
Paul Edward Nickels
Gabriel Vincent Pesce



Pyramid

The following were extended and accepted invitations to membership to Pyramid this term:

John F. Coffin
Edwin G. Cornell
Matthew J. Cummings
Edward E. Lewis
Carl C. Michaels
Henry J. Payeras
Frank S. Senior
James W. Spencer

A football game between Rod & Bob and Pyramid was played on the quadrangle this term. Rod & Bob won a 12-6 decision in overtime. Pyramid supporters protested the game, claiming that their side only had two downs in the overtime period, but was promised four.

Profile--

Carroll R. Harding, C.E. '10

By NATHAN EHRLICH, EE '49

Photographs courtesy Pullman Company

Carroll R. Harding

When the work of construction and maintenance of Pullman cars was separated into two individual companies, a group of fifty-nine railroads purchased The Pullman Company and asked Carroll Rede Harding to assume its presidency.

The Pullman Company was originally incorporated in 1867 at Pullman's Palace Car Company, but in 1900 the name was changed to The Pullman Company. The company both built and operated all the sleeping cars used by the American railroads. Since June 30, 1947 the job of manufacturing the cars is carried on by a separate company.

The Pullman Company now only furnishes and operates for the railroads of the country sleeping cars in such numbers as to meet the traffic requirements of each system. The individual railroad companies determine in what trains and over what routes the cars are to be operated and also take care of the individual sales of tickets and reservations of accommodations. The Pullman Company has charge of the operation and maintenance of the large fleet of sleeping cars. Accommodations provided nightly are equivalent to a mammoth hotel with 175,000 rooms.

The company repairs, maintains, and cleans the cars and also furnishes the needed supplies and personnel to provide each guest with the personal service he or she likes to enjoy. Every night each bed is provided with fresh clean linen and sanitary blankets. One can hardly appreciate the size of the cleaning and laundry bill which must be paid each week. Some of the linen is washed by commercial laundries, while the remainder is washed in the ten modern laundries which are owned and operated by The Pullman Company and devoted exclusively to cleaning the supplies of Pullman cars.

The watchword of the organization is service. Personal courtesy and attention is given every passenger. To provide porters and conductors for each train, and to prepare cars for service requires an organization of approximately 28,000 employees.

Charter Member of Tau Beta Pi

Carroll R. Harding was born in Hallowell, Maine, but was educated in the public schools of Baltimore, Maryland until he entered Cornell University in 1907 upon graduation from the Baltimore Polytechnic Institute. While at Cornell he was a charter member of the Cornell chapter of Tau Beta Pi, national engineering honorary society. During his last summer at Cornell he worked with a field party marking the international boundary between Alaska and Canada. In 1910 Mr. Harding graduated, having completed the four year civil engineering curriculum in three years. During the next three years he held several drafting and surveying jobs which took him from Canada to Panama.

In November, 1913 he began working for the Southern Pacific Railroad and stayed with that organization until assuming the presidency of The Pullman Company. He entered the Southern Pacific Company as a draftsman and was successively promoted during the next ten years to Chief Draftsman, Assistant Consulting Engineer and then to Consulting Engineer in June 1923.

Active in many professional societies, Mr. Harding served on the Committee of Bridge Design and Construction of the American Society of Civil Engineers. He became chairman of the Committee on Track of the American Railway Engineering Association and served on the Committee on Car Design of the American Railway Association. In 1922 Mr. Harding was elected president of the Cornell Society of Engineers.

Within the Southern Pacific Company he became Chairman of the

A common sight to any Pullman traveler —a porter fastening the berth curtain as the last step in preparation of the Pullman section space.

Standardizing Committee to modernize the company's standards for bridges, structures, roadway, and equipment. He advised the Chairman of the Executive Committee on engineering matters and made a critical review of all proposed additions and betterments for the system. He was placed in charge of the inspection of all materials and equipment purchased by the Southern Pacific Company and its subsidiaries. During this period he had charge of the design of all important additions to the company, including the Torance Shops at Algiers, La. for the Pacific Electric Railway and the shops and bridges of an extension of the Southern Pacific de Mexico Railroad.

In June, 1925 Mr. Harding moved to San Francisco and assumed the title of Engineer of Standards. He reported directly to the president of the company. He continued as Chairman of the Standardizing Committee and retained the responsponsibility for the inspection of materials and equipment purchased by the company. He took charge of a survey to replace the train ferry at Carquinez with a bridge and wrote the report of when, where, and how to build such a bridge. He took charge of the construction of this bridge, the Suisan Bay bridge, which was completed in 1930.

In 1920 he took up the study of insurance practices of the system Insurance Committee. In 1929, his title was changed to Assistant to the President. In this position Mr. Harding retained his former responsibilities and added to them that of being Southern Pacific's representative in the Pacific Transportation Securities Company, a group of bus lines now known as Pacific Greyhound Lines. He was elected Vice-President and Director of the bus system.

In 1932, Mr. Harding dropped the chairmanship of the Standardization Committee and his inspection duties. However, his responsibilities were increased by becoming Vice President and Director of nine railroad companies which were subsidiaries of Southern Pacific Company. Later, other additional subsidiaries were placed under his direction.

On June 30, 1947, Mr. Harding was elected to his present position of President and Director of The Pullman Company. At that time he resigned all his railroad affiliations.

Interior of a Pullman commissary car which houses and feeds the employees. The large supply of linen and items of similar nature used by the traveling public are supplied from this car.

The Editor's COLUMN

Engineering Research At Cornell

Many engineering students and alumni know of some of the research being carried on in the College of Engineering at Cornell, but only a few realize the significance of this program or know just how diversified and important it is.

To the members of the faculty a thoughtfully conceived and well-executed research program means that they will not become isolated behind the walls of routine instruction. It gives them a chance to continue to grow intellectually and is one of the most important factors in retaining the broad outlook held by the Cornell faculty.

Students will find that most of the men in charge of the various research programs would be happy to see an increased amount of student interest in their work

The underlying idea in all research sponsored by the engineering college is that it shall be fundamental in character as distinguished from ordinary commercial testing and consultation. The College of Engineering sponsors some of the research programs by itself, with the Army, Navy, and various industries cooperating in others.

Current Research Programs

An excellent example of the research being carried on at Cornell are the radio astronomy experiments described in the November issue of the CORNELL ENGINEER. Among the other programs now in progress are the American Iron and Steel Institute's investigations of light gage steel and bond stresses in reinforced concrete. The Army's research on soil solidification, and oscillograph equipment, the Navy's program on soil investigation by aerial photography, and many others of equal importance.

As Cornellians we can be proud of the outstanding part research plays in our engineering schools and of the advantages it brings to the faculty and students.

PROMINENT

Carl

Carl P. Irwin, CE

Most prominent engineer as far as this magazine is concerned is Carl Irwin, whose name stands at the top of its masthead. An easy-going drawl in his voice marks him as a stranger to these parts, and, sure enough, he's from Springfield, Missouri. He came to Cornell's School of Civil Engineering in the fall of 1942, encouraged by a John McMullen Regional Scholarship and the fact that his father is a field engineer with the Portland Cement Association.

Carl was able to finish one term before the draft board called, and spent his next three years in the Air Corps. They sent him to school for a year at Hamilton College studying meteorology, but then decided they didn't need any more meteorologists and trained him to be a bombardier-navigator and a Second Lieutenant. Much of this occurred in the South, where Carl says he picked up some of his drawl. The army let him go in time for him to reenter the School of Civil Engineering in the spring term of '46, so that, with the help of a summer session, he will graduate in February of this year. He tried to persuade his younger brother to come to Cornell too, but somehow Purdue won out.

Besides being Editor-in-Chief of the ENGINEER, Carl is a member of Theta Xi, Tau Beta Pi, Pyramid, and Chi Epsilon, honorary civil engineering society. He is president of Pyramid this term, was house steward of Theta Xi for a term, and worked on last year's Junior Week committee. He has divided his three summers between a summer session at Cornell, the Civil Engineering Summer Camp, and a job with the Missouri State Highway Department, for whom he traveled around inspecting highway construction and repair projects. He joined the ENGINEER staff in the spring term of 1946, and became compet manager and then Associate Editor in the spring of 1947. One year later he was elected Editor-in-Chief of the magazine.

Carl expects that after graduation he will go into equipment sales in the civil engineering field. He has no immediate marriage prospects and intends to head as soon as possible for the Midwest or West, where he won't have to put up with these cold northern winters. The ENGINEER wishes its graduating Editor-in-Chief much happiness and good fortune in his work.

Warren R. Higgins, ME

The winning of a McMullen scholarship was the impetus that brought Warren to the Cornell campus in the fall of 1942, from Shorewood, Wisconsin. His first acquaintance with the university was a brief one. With less than two terms under his belt, the Air Corps called up their enlisted college men and Warren was off on an extended three year "vacation."

Cadet training school was hard work. But flight school was even tougher. Nevertheless, Warren came through on top and received his pilot's wings at West Point's field at Newburgh, N.Y. in March, 1944. He was sent to B17 pilot training school and upon completion to B-29 school in Nebraska. Then came ten months of overseas duty and rigorous combat flying. Based within striking distance of the Japanese mainland, Warren flew twenty-two missions from Tinian to Japan. He was awarded the DFC, four air medals, and several other honors. Stateside again in November of 1945, he received his discharge in December.

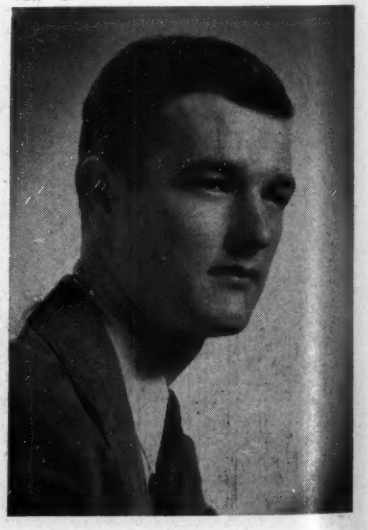
Warren came back to Cornell as a second term freshman in February of 1946, his graduating year as of 1942. Assuming an active interest in campus activities, he was one of three compets trying for berths on the ENGINEER. Carl Irwin and Dan Roberts were the other two.

In July 1946, he married the girl he had met in Nebraska when he was a B-29 trainee.

Warren has made Ithaca his year-round home the past few years, doing construction work in the summer and maintaining an excellent scholastic record during the school year, having attained the Dean's List two terms. Warren is the cataloguer in Tau Beta Pi, having charge of alumni records and correspondence, associate editor of the ENGINEER, a student member of the A.S.M.E. and is president of the newly installed national honorary mechanical engineering honorary, Pi Tau Sigma.

A February graduate, Warren considers the production or sales engineering field to be more to his

Warren



ENGINEERS

liking than any other. He would like to return to the midwest and hopes the company he joins will have that advantageous location. We wish you the best of luck.

Ray C. Bump, Arch

Wandering amid littered drafting tables in the loft of White Hall where prospective architects dream dreams and pencil proud structures skyward, we found Ray Bump hunched intently over an extensive layout drawing of his thesis project. After the usual amenities between an architect and an outsider, which consist entirely of a brief orientation of the latter as to the "actual" results of the recent Architect-Civil Engineer football game, we gathered the following data on this very prominent student of architecture.

From Brocton, Mass., where he early shaped his career by taking the architectural branch of the college preparatory course in high school, Ray attended Wentwoth Institute and then served several years in the Civil Engineers Department of the U.S. Coast Guard. Impressed by a friend's description of the school, he entered Cornell in 1945. The desire to be an architect had held him ever since, as a lad, he had watched the building of a house across the street. An almost equal interest in music found him gaining experience as a trumpeter in various dance bands, but apparently the coincident practicality and creative power of the drawing board won out over the more colorful trumpet.

Ray

But music and architecture are merely the foci of his interests. His activities encompass a much wider field of endeavour and have brought him many honors. As varsity football manager in 1947 and in charge of the lighting displays this fall, he has done his bit toward campus extracurriculars; and in recognition of his abilities he has been honored by membership in Gargoyle, the honorary society of the

(*Concluded on page 26*)

Stephen D. Profilet, EE

A tangible tinge of the South in his voice and a friendly smile are the first indications of a genial personality which surely must make a host of friends for Stephen Profilet. At St. Joseph's High School in his home town of Cairo, Illinois —"The Gateway to the South" (South that is!), three years of varsity basketball plus burnt cork and harmony formed the nucleus of Steve's academic activities.

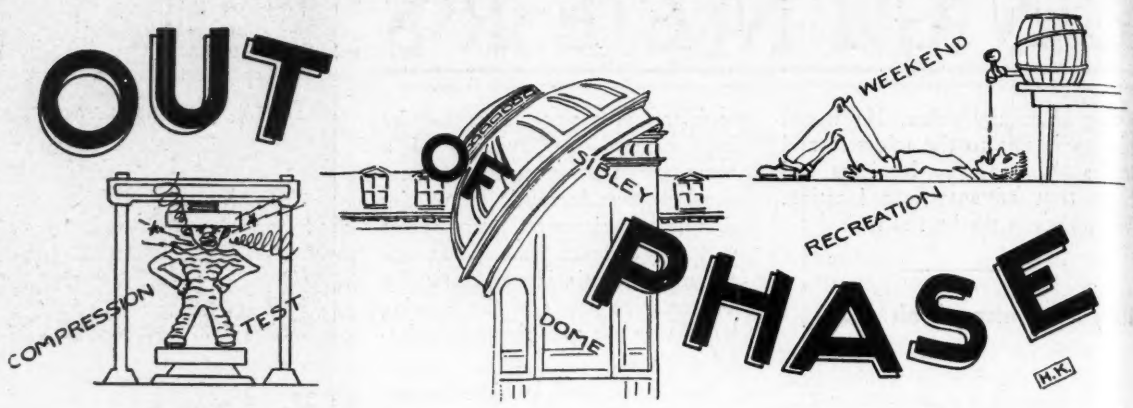
After graduating with the Class of '44, Steve was beckoned by Uncle Sam, and he soon found himself at Mercer University in Macon, Georgia as a member of the V-12 program. Here his varied talents found expression in the feature-editorship of the "Mercer Cluster"—the campus weekly, and membership in the Sigma Alpha Epsilon fraternity and Phi Eta Sigma, a freshman honorary. Later, he was transferred to Bucknell where varsity football gave him a chance to show his physical prowess. Next, the Navy sent him to the University of Rochester, and finally the fateful day found Steve at Cornell, a midshipman in the N.R.O.T.C.

Steve

Came the fall of '46 and Civilian Profilet reenrolled in the Electrical Engineering School here at Cornell. But Steve decided that the Navy had given him many opportunities, so he continued in the N.R.O.T.C.; spending the last two summers on cruises. He is now a company commander and is expecting his commission in February.

Steve's record in Electrical Engineering has been enviable; for, not only has he maintained his scholastic standing, (having received a McMullen Undergraduate scholarship this term), but his extra-curricular activities also speak for his abounding energy. He is president of the Delta Club, corresponding secretary of Tau Beta Pi, and a member of the Newman Club and Eta Kappa Nu, the Electrical Engineering honorary. Steve maintains other records, as well, for it is an open secret that he also holds the "Chug-a-lug" record of the Delta Club. In addition, almost every evening one can find him behind the cash register in the Straight cafeteria pounding the keys as the customers flow past.

After February, the Navy will see more of Steve, for he will be assigned to active duty for at least two years. And after that, a naval career depends on two things—the Navy's appeal to Steve and Steve's appeal to the Navy. He believes that he owes the Navy something for those eleven sponsored semesters!



I have noted with sadness that many engineers are going into prelims with the look on their faces that is usually seen on condemned convicts walking the last mile. This is indeed an unhealthy attitude.

A prelim *should* be a pleasant experience, an opportunity for the tired student to have a fairly private seat in a fairly quiet room away from the hustle and bustle of the other classes of the day.

The engineer should in all cases be able to fill one prelim book completely and accurately in ten minutes and spend the rest of the period in omphaloskosis.[1] Yet, I am fully aware that most engineers have not reached this blissful state of relaxation during prelims.

Therefore, with a view towards decreasing the sale of Nodoze and increasing the marks of each and every engineer I intend to give here the long-hidden secret of success.

1. Contemplation of the Navel. An art well-known to the Greeks and various yogas. Introduced to Cornell by a math instructor of no mean ability by name of Holtzinger. On a diff equations prelim, after stating the problem, he added, 'Solve by Undetermined Coefficients or Omphaloskosis. At that time I was somewhat unskilled in the ancient art, and Undetermined Coefficients did much more for the rest of the class than Omphaloskosis did for me.

Anyone who has taken Descriptive Geometry knows how well one can do on a prelim if the questions are given in advance. Given the questions, one can always dig up the answers.

With no further fanfare, I hereby give to the world and the fraternity files, Prelim questions such as you may expect to receive on your next prelim in . . .

Freshman English:

Freshman English:

(A) Write a ten-thousand word explanation of this sentence—"Stepped in what?"

(B) How old was Chaucer's mother when she was born?

Calculus 161:

Part 1: Evaluate the following indefinite integral in terms of elementary functions.

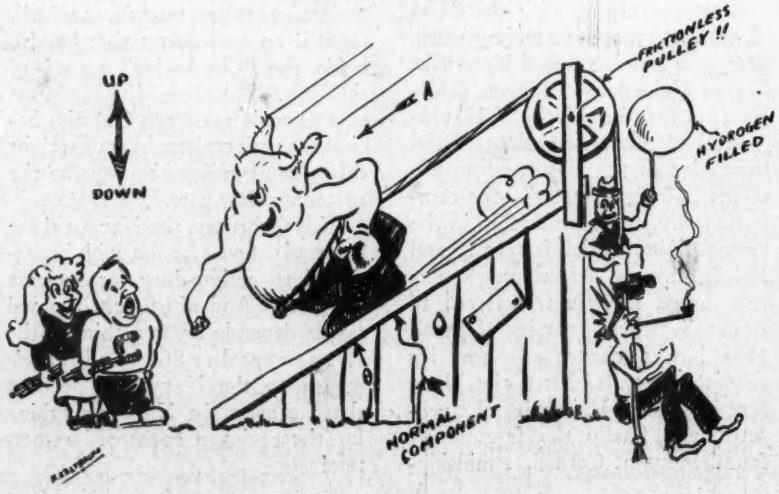
(a to the X^2 power) dx

Part 2: Find the work done in finding the work done in finding the work done by a three-legged man lifting a pot of rabbit stew from the kitchen stove to the star Betelguese. Show all work.

Heat-power of EP 8121:

Design a complete power plant to take in coal from Scranton at 4 p.m. daily, and supplying nine billion megawatts. Assume standard temperature and pressure. Compute; pressure ratios, temperatures, materials required, number of men employed in construction and operating power plant, number of molecules in a mole, ratio of this enthalpy to that enthalpy, and everything else that you would compute if you knew as much as the professor.

Problem in mechanics . . .



Mechanics:

Assume that an elephant, color pink, mass 22,000 kilograms, is sliding down an inclined plane. The

(Concluded on page 26)

Graduating Class of February, 1949

SCHOOL OF MECHANICAL ENGINEERING

Fisrt row, left to right: N. A. Bracht, S. K. Kempner, B. Petterson, Jr., R. J. Morley, S. H. Lutzky, G. I. Roshkind, W. F. Podgorski, E. L. Velte, R. J. Gottlieb, H. N. Roehl, L. N. Burke, L. E. Daum, W. B. Coulter, A. L. Feldman, P. A. Taylor, S. C. Volpe.

Second row, l. to r.: W. L. McKenica, S. L. Trilling, W. Berliner, N. A. Smith, D. S. Dulaff, J. S. White, S. M. Birnbaum, D. H. Spielmann, W. H. Scott, W. J. King, (Director), Miss J. Schneider, H. F. Hodgkins, Jr., A. Misciagna, J. D. Eves, R. D. Norris, D. P. Feiman, D. D. Marantz, P. C. McMaster, D. C. McCarthy, (Hotel Student), H. L. Cooperman, M. N. Blatt.

Third row, l. to r.: J. D. Gilbride, F. J. Matte, V. H. Zelov, E. J. Ecock, O. W. Bilharz. Jr., J. P. Wollam, J. L. Strong, Jr., G. H. Barnard, A. E. Rasmussen, G. K. Painter, W. C. Rankin, B. F. Marcinowski, E. J. Bakelaar, R. P. Hempel, A. D. Davies, D. H. Davis, H. L. Dibble, R. M. Gammie, (Hotel Student), C. H. Reynolds, Jr. (Hotel Student), W. W. Patten, Jr.

Fourth row, l. to r.: D. A. Noyes, C. W. Kain, H. Sternfeld, Jr., R. E. Hopkins, Jr., G. H. Hull, L. E. Hahn, E. W. Staehle, F. F. Albert, D. H. Scott, S. Joyce, W. C. Bradley, S. Leezenbaum, R. R. Rothermel.

Fifth row, l. to r.: J. H. Flournoy, W. E. Shannon, J. E. Lamp, F. Koebel, D. E. Rogers, S. Rosen, G. H. Halsey, W. R. Higgins, A. H. Amick, J. T. Synnestvedt, P. E. Harmon, G. L. Clegg, J. S. Osborne.

SCHOOL OF ELECTRICAL ENGINEERING

First row, left to right: R. B. McCarthy, D. W. Deno, J. Spergel, N. Ehrlich, A. Zisselman, Prof. E. M. Strong (Class Adviser). A. Markham, M. Davis, G. W. Krowl, A. Nash, W. J. Karplus.

Second row, l. to r.: E. M. Greenthal, S. D. Plotkin, M. Levy, G. F. Kaplan, T. H. Yaffe, L. H. Hill, Jr., D. A. Morken, R. M. Caldwell, W. J. Vane.

Third row, l. to r.: H. F. Baumer, V. Caleca, L. L. Gray, W. R. Elmendorf, R. J. Frank, J. J. Edwards, J. T. Hintlian, W. F. Floyd, F. L. Maloy.

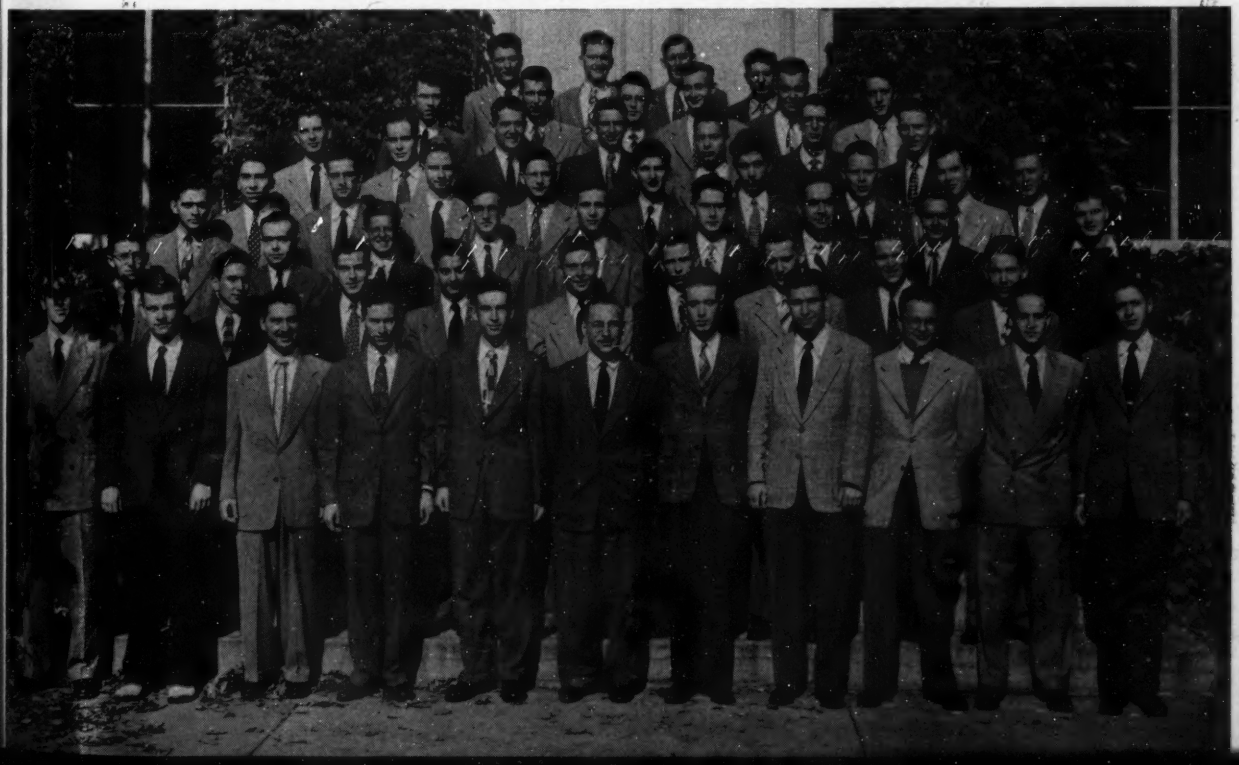
Fourth row, l. to r.: A. Calvani, D. D. Ward, Jr., P. R. McIsaac, W. F. Kamsler, G. W. Killian, W. R. McNay, R. T. Dean, S. Profilet, E. L. Nagel.

Fifth row, l. to r.: L. Singer, N. Schneyer, G. F. Oberrender, Jr., E. B. Galton, G. Howitt, C. W. Hooper, W. J. Plate.

Sixth row, l. to r.: R. G. Winkelpleck, J. I. Whittlesey, H. T. Ward, S. Paskow, N. E. Snodgrass, R. McKay.

Seventh row, l. to r.: R. M. Whalen, H. W. Wittmann, A. L. Thomas, Jr., L. G. Stepanoff.

(*Senior class photographs of Chemical and Civil Engineers will appear in the February* CORNELL ENGINEER)



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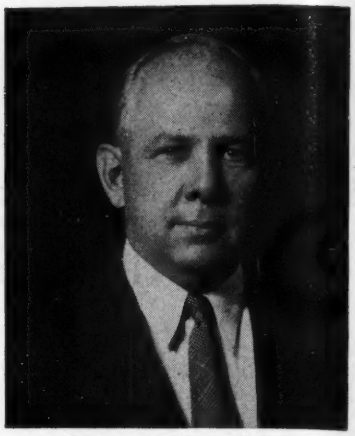


Creed W. Fulton, M.E. '09

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University its graduates and former students and to establish a closer relationship between the college and the alumni."

New Year's Resolutions

This is the time when we usually appraise what happened to us last year, and having done so, highly resolve to do better in the New Year.

I, for one, have resolved never again to write a message without giving it careful scrutiny before it is released. This resolution results from two "fan" letters, one from a classmate, Bill Broadfoot, of Wilmington, N.C., who, commenting on my October message, expressed amazement that I seemed to have majored in English, instead of Engineering. Bless you, Bill, for the compliment and the encouragement.

The other message came from one I regret I cannot place. It was sent on a post card which unfortunately must have come by rain, judging by its blurred condition. It was post-marked Wallingford, Connecticut; and if reading spectacles and a magnifying glass have not deceived me, the name appears to be D. Lloyd, although I am not too sure.

However, the writer took me to task, and quite severely I should say, for—to use the vernacular—"Murdering the King's English" in my November Message. Specifically, I was accused of using split infinitives. Furthermore, Cornell engineers in general were reprimanded for the same crime.

My critic went on to say "The Cornell Engineer Magazine could be tops if its writers could write English correctly." Also, it was suggested that I read H.I.E.E. "Electrical Engineer" of August, 1948, page 73, about English Language, also the same publication of October, 1948, page 900, about what books to read, and finally, Macauley's "Essays."

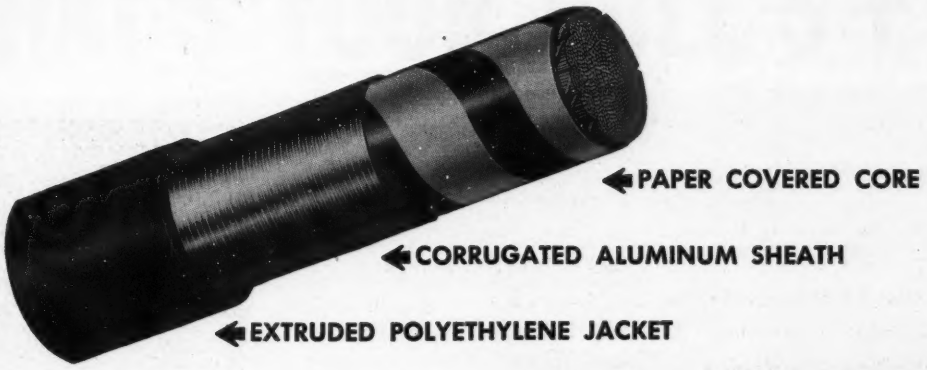
Now I hardly know what to do. A classmate praises for writing good English and a critic, who is unknown to me, but whom I should like to know, chastises me for not knowing how to write.

Well I have made my resolution, and it is to try to please D. Lloyd, and others of the same mind, just as often as I can, without becoming unnatural. However, it seems to me that these good critics should allow us engineers some leeway in expression. If engineers can split the atom, they should have the privilege of splitting the infinitive—occasionally at least.

Thanks, D. Lloyd, for a suggestion which I hope will not go unheeded, and a very happy and prosperous New Year to you all, with the fervent hope that each and everyone of us will resolutely work to carry out the program we have set for ourselves in 1949.

CREED W. FULTON

Newsworthy Notes for Engineers



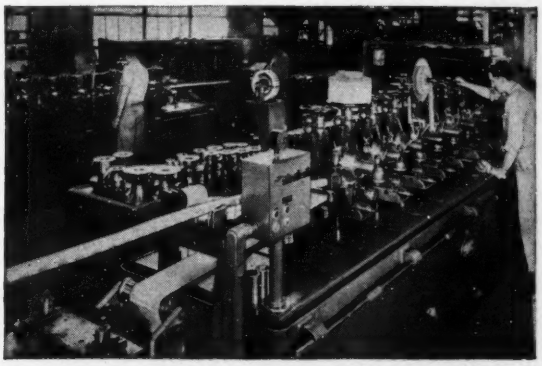
PROBLEM:

How to put a new type of covering on telephone cable

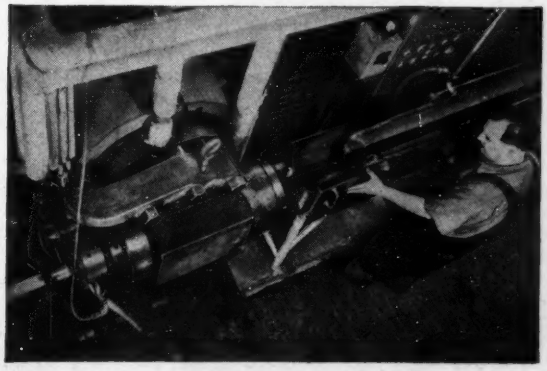
Make a new type of cable sheath no one has ever made before—make it to rigid specifications—make it fast! That was the challenge put up to Western Electric's manufacturing engineers.

The new type of cable sheath—developed through cooperative research at Bell Telephone Laboratories and Western Electric Company—is a valuable alternative to the traditional lead covering for telephone cable. It is called Alpeth. "Al" stands for an inner shield of aluminum; "peth" for the outer coating of the plastic, polyethlene.

To produce this new cable sheath, Western Electric engineers developed the Alpeth production line—a combination of new machines and new manufacturing techniques—which turns out finished cable in a fast-moving, straight-line operation.



From the desert-dry 125° F "hot room" where thoroughly dried cable cores are stored, the core moves into this machine. An aluminum strip is fed from a supply reel underneath. After being corrugated to provide flexibility and strength, the aluminum strip is wrapped around the core and flooded with a sticky protective compound.



The aluminum-clad cable then passes into this machine and comes out seconds later with an extruded coating of flexible, impervious, gleaming black polyethylene. Finally, after a 100-foot bath in a cooling trough, the finished cable is wound on reels and readied for shipment to Bell Telephone companies.

Engineering problems *are many and varied at Western Electric, where manufacturing telephone and radio apparatus for the Bell System is the primary job. Engineers of many kinds—electrical, mechanical, industrial, chemical, metallurgical—are constantly working to devise and improve machines and processes for production of highest quality communications equipment.*

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

Out of Phase

(*Continued from page 22*)

coefficient of sliding friction as determined experimentally by rolling soft-boiled eggs down the plane is 0.4. There is a South South-West wind blowing at a velocity of 8 mph. The effective frontal area of the pachyderm is 19 square feet. A rope is attached to the elephant. This rope is passed over a pulley. The resisting torque of the pulley is 2 dyne-ft.

At the other end of the rope are three climbing men, two midgets and one nearsighted Cherokee. The midget's names are George and John, while the Cherokee is named Henry Splash-in-the-vacuum tube. All three are climbing upwards at the rate of 25 cm/year. The elephant slides down-hill with uniform velocity.

Two lady engineers standing at the bottom of the inclined plane have a combined weight of 335 pounds. Assuming that entropy is always changing, is the elephant sliding downhill head or tail first?

Chemistry 105:

(A) Give complete details of laboratory preparation of the Philosopher's Stone.

(B) List all the formulas that you have been able to memorize up to the present time.

(C) Reproduce exactly, from memory, the twenty-four columns of the tables of heats of combustion appearing on page 1189 of the *Handbook of Chemistry and Physics*.

History 101:

1. What was the exact minute of what hour of what day that General Lee said to his batman, in speaking of General Grant, "That damn yankee!" Give a 200 page dissertation on the political, economic, mathematical and personal events and disturbances leading up to the utterance of this obscure statement.

2. On page 44, of your three hundred page reading assignment for last week a certain twelve letter word was used to describe the facial expression of one of the members of the ninety-fourth coalition cabinet formed by the King of Tanna-Touva during the three weeks rebellion of Spring, 874 BC. What was that word?

Prominent Engineers

Ray Bump

(*Continued from page 21*)

School of Architecture, Quill and Dagger, and the presidency of Tau Beta Pi.

And even these extensive activities are well matched by his current thesis project. For on the many rolls of plans and drawings scattered about his lair in the lofty heights of White are the ideas for a no less than magnificent aquarium-park. Impressed by the need for just such a development in the city of Boston, and driven by his particular interest in the design of large buildings in the modern idiom, and the challenge of a field scarcely touched by the three existing structures of this type, Ray thinks and eats aquarium while his flood of ideas take shape before him. No mean plan, this—embracing a quarter of a mile of water front, with several buildings and myriad shrub-lined pools, all bound together in a flowing continuity which leaves no line or angle to chance in its striving for a striking combination of workability and esthetic value.

Playing a prominent supporting role in a new, exciting drama of the skies is the 21½-ton welded steel structure illustrated at the left. On it was mounted the 200-inch mirror for the giant Mt. Palomar telescope during the delicate grinding and polishing operations. Now it is the mirror's permanent base in the world's greatest eye. Association with this pioneer scientific project is a typical example of B&W's versatility and resourcefulness for serving industry's unusual as well as ordinary needs. Through its great diversity of activity, B&W offers excellent career opportunities in research, engineering, production, sales and other vocations to technical graduates.

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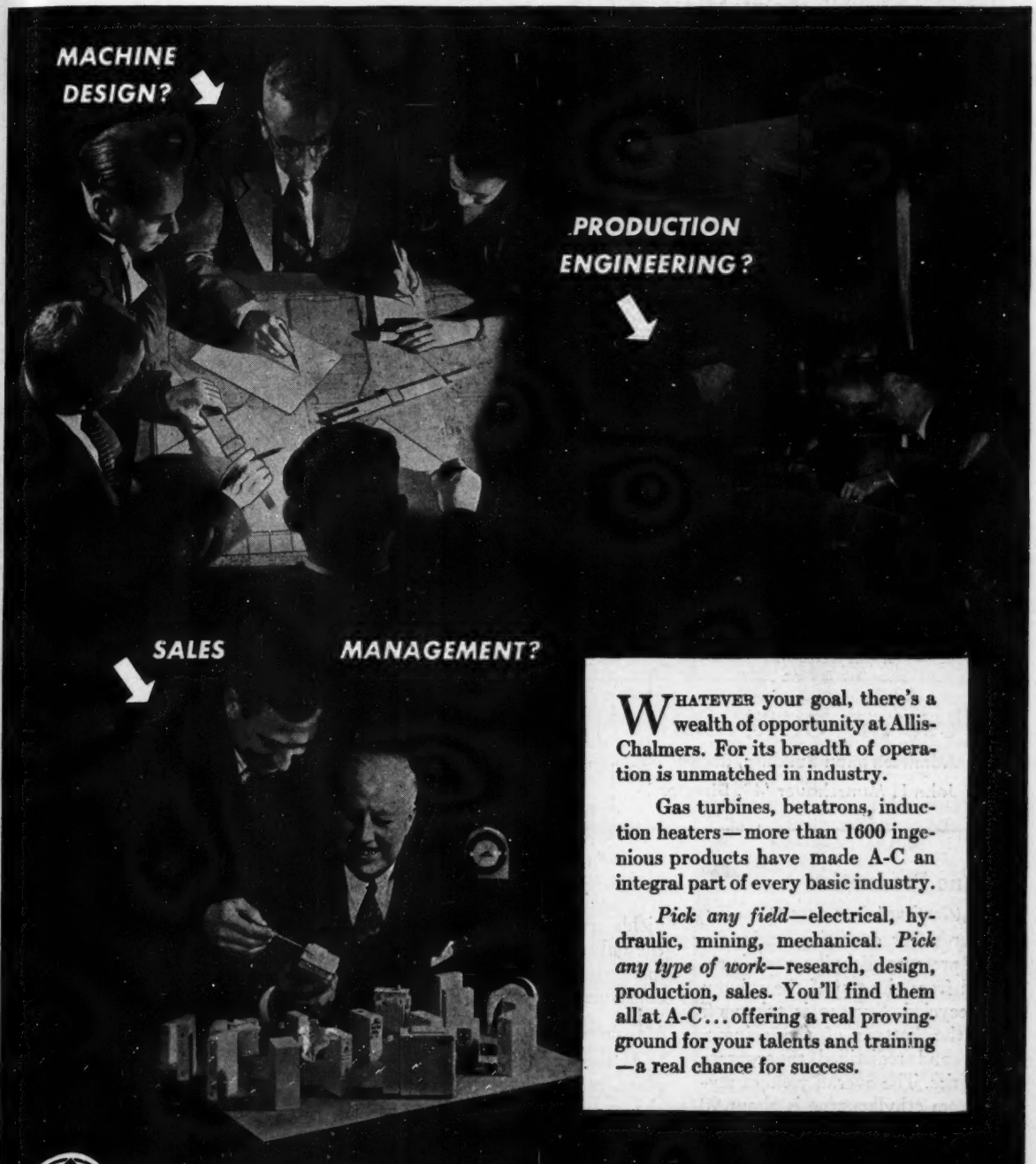

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Styrene Production

(*Continued from page* 14)

another tower operating under reduced pressure. Ethylbenzene is removed from the top of the column and recycled. Styrene is taken off from the bottom of the column, cooled and redistilled to separate impurities. The overall yield of styrene from ethylbenzene is about 90 percent. An inhibitor such as paratertiary butyl catechol is added to the purified product which is ready to be shipped. Shipping is done in insulated tank cars to keep the temperature down and prevent polymerization.

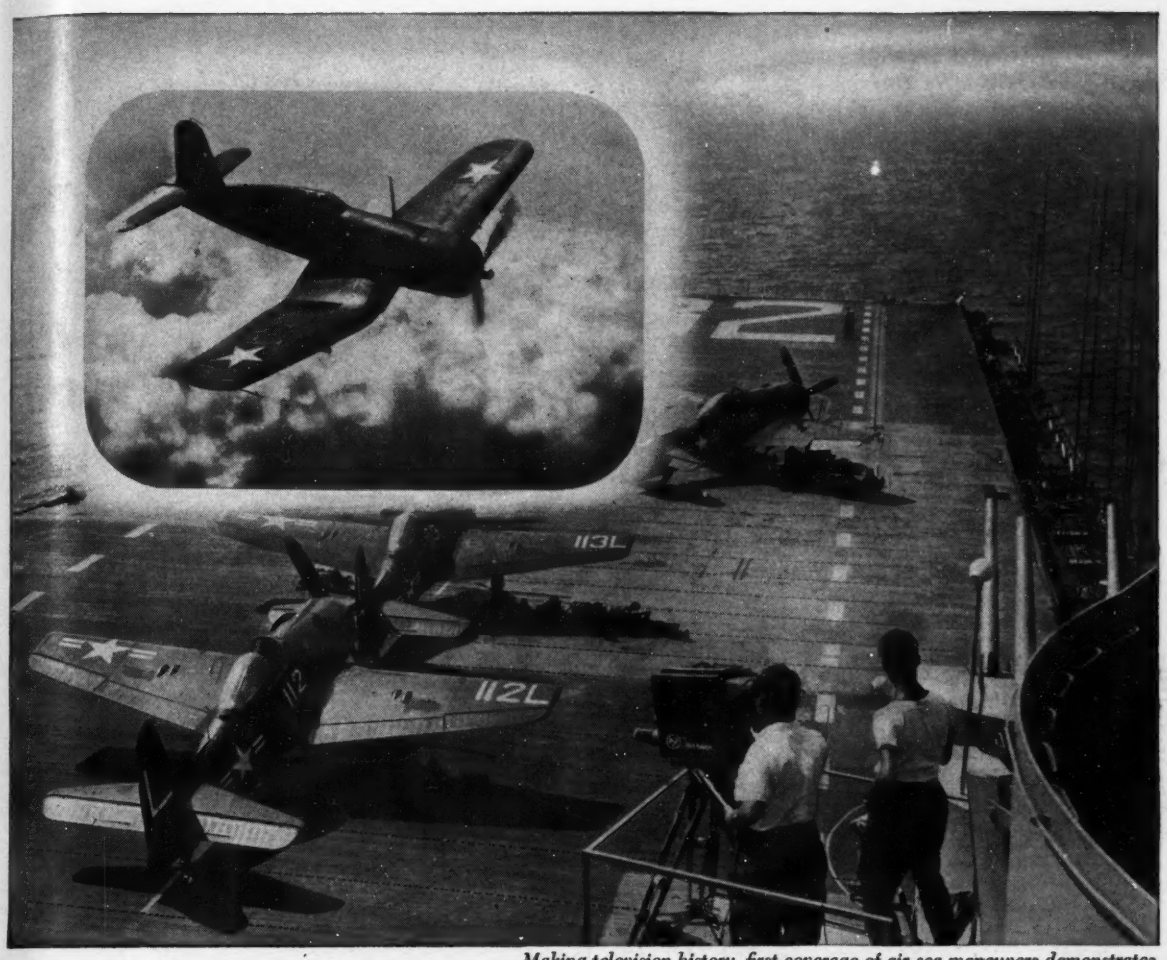
A process similar to that described was employed by the I. G. Farbenindustrie in Germany. Investigations since the war have shown only minor variations between their plants and many of those producing styrene in the United States. The yields are essentially the same with the only differences lying in equipment details and the materials of construction.

Monsanto Being Rebuilt

At the start of the war, the Dow plant at Midland, Michigan, was the only producer of commercial styrene in the United States. At the end of the war, production had expanded to more than 200,000 tons per year. The loss of the Monsanto plant at Texas City in April, 1947, which manufactured 25 percent of the national production, and the drop in demand for synthetic rubber have probably lowered the average figure since the war. However, the Monsanto plant is being rebuilt and will soon be back at full production.

With the slackening off of demands for synthetic rubber, the present emphasis has shifted to the manufacture of polystyrene resins and the synthesis of other organic compounds. Polystyrene forms malleable thermoplastics which are particularly well-suited for injection molding. They are strong and tough and are crystal clear giving them an unlimited range of possible colors.

Nevertheless, in view of the unsettled conditions in the East Indies, the high cost of South American rubber, and the possibilities of further economies in the production of Buna-S rubber, the synthetic rubber market should not be ruled out in plans for the future of styrene.



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Action was beamed by radio to shore, then relayed over NBC's Eastern television network. Reception was sharp and clear on home television receivers . . .

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Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RCA RADIO CORPORATION of AMERICA

Scientific Dyeing

(*Continued from page* 9)

On the other hand, the ultimate strength depends upon the strength of the individual fiber itself. Therefore, in order to investigate the effect that dyes and other textile chemicals have upon the textile fibers, studies are made of the tensile characteristics of single fibers or hairs. In the case of wool a single fiber is calibrated on a special analytical balance by finding out the weight necessary to stretch the fiber to various values of elongation up to 30%. It has been found that wet wool fibers are reproducibly elastic up to this elongation as long as they receive no treatment which damages their structure. By subjecting the calibrated fibers to various treatments it is possible to determine what the fiber will stand without damage. Thus, the effect of a new process in regard to damage can be determined in the laboratory before being put into practical application, and failure of the product in use is prevented.

Many other instruments come into use in the scientific study of dyeing for specific studies. Optical instruments, particularly the infrared and ultraviolet spectrophotometers, are useful for the identification of components, both inorganic

(*Concluded on page* 32)

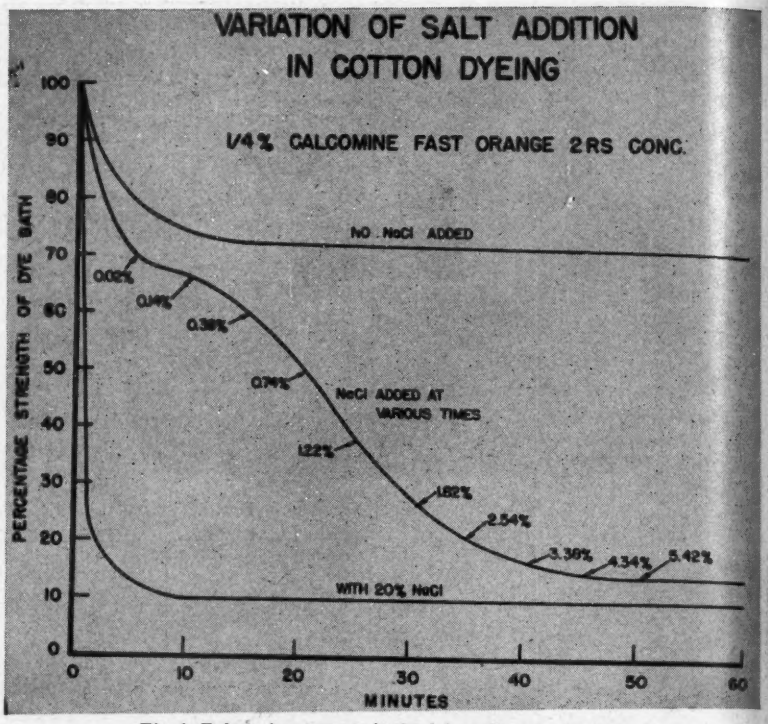

Fig. 1. Exhaustion curves obtained from Dyeometer data.

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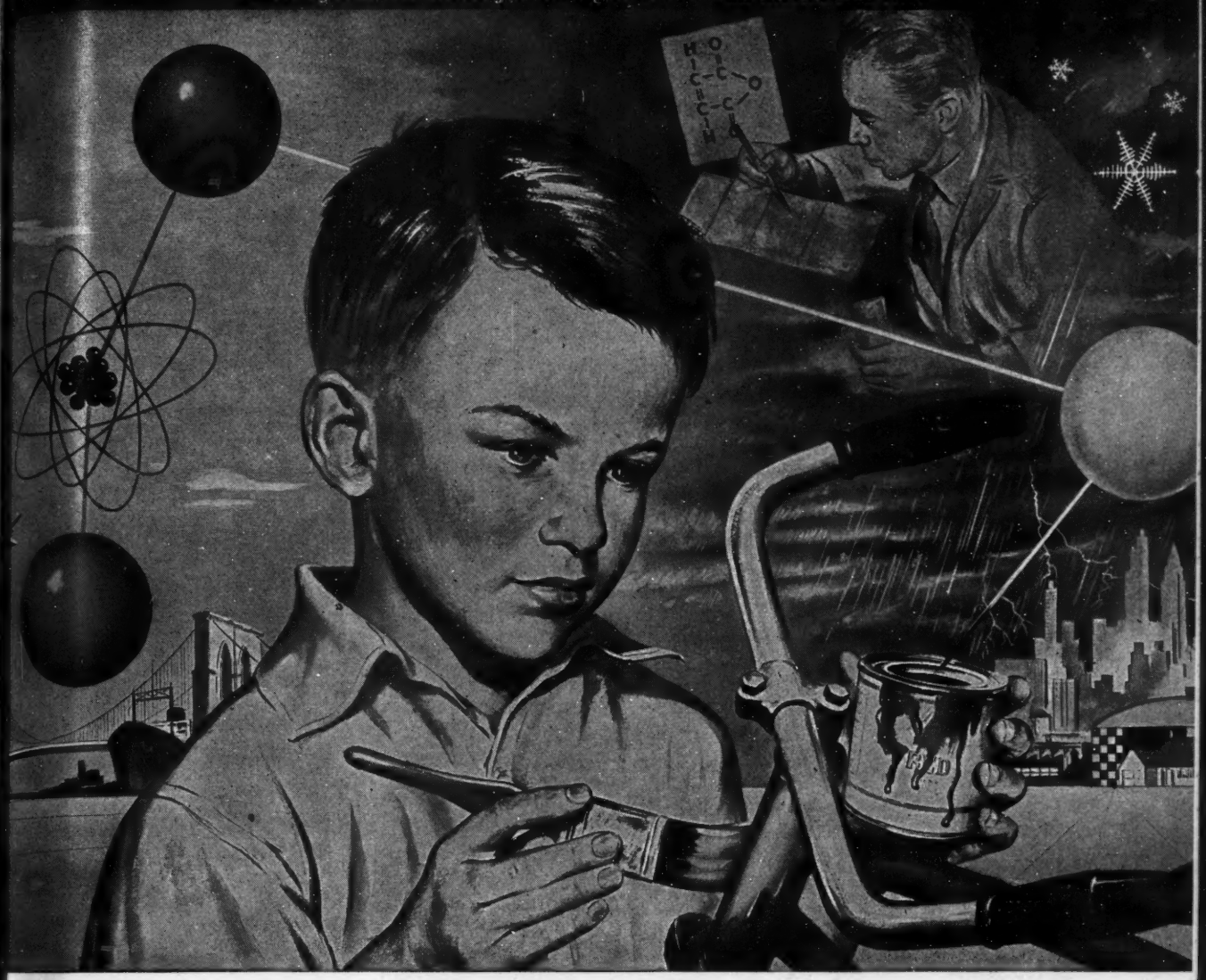

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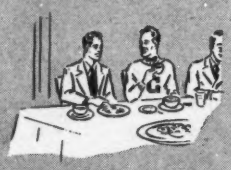

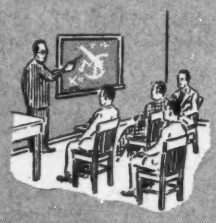

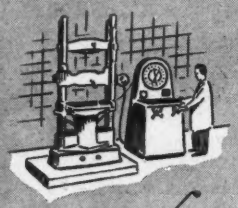

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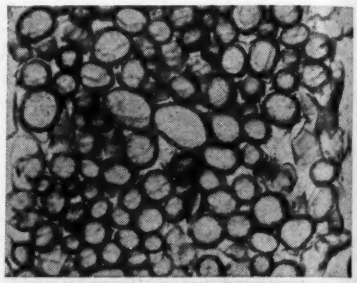
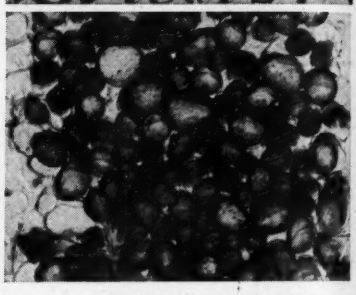
Scientific Dyeing

(*Continued from page* 30)

and organic. The visual spectrophotometer has had extensive use in color analysis, and, present research in this field will be applied in the future to accomplish more simple color matching and recording of color properties. X-ray has been of value in the field of molecular structure, and along with electron diffraction has explained many phenomena. For other studies the application of electronics has simplified the procedures and made possible faster and more reliable data.





Cross-sections of dyed wool, showing poor peneration of dye (top), and excellent penetration of dye (bottom). A microscopical study of the distribution of dyes in fabrics can be correlated with properties such as color fastness and color strength.

The application of scientific principles to the art of dyeing should make it possible to produce better dyeings at a lower cost. The success, however, does not end when the data are obtained in the research laboratory, since the practical accomplishment depends upon the cooperation of the engineer to translate the scientific data to technological data and thus make it applicable for the dyer to use in his practical way. Much has been learned from the scientific point of view, and the further application to the advancement of the art depends to a large extent upon the engineer.

DU PONT Digest
For Students of Science and Engineering

a giant on the farm

Products of the laboratory are saving time, toil, money for the American farmer

Through chemistry, farmers are gaining control over many of nature's uncertainties. Costly losses of crops and livestock are being curtailed or prevented. Efficiency is increasing. New applications of chemistry to agriculture are becoming more important than ever as demands for more production increase.

Today, new organic insecticides and fungicides help control insects, plant diseases and blights that threaten crops. Seed disinfectants and protectants help guarantee bountiful harvests by protecting crops in the critical period after planting. Plant hormones hold fruit on trees until fully ready for picking.

Days of labor saved

Du Pont weed killers and explosives accomplish in minutes tasks that used to take hours or days of back-breaking labor. With 2,4-D farmers can kill weeds without harming certain crops. Dynamite removes stumps, digs ditches for draining and irrigation, and loosens the soil to forestall erosion.

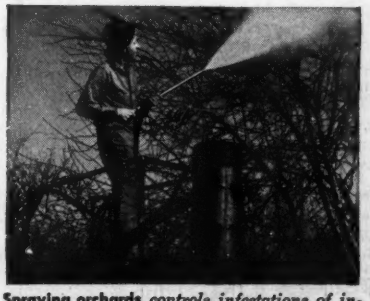
New fertilizer formulations meet the changing nutritional requirements of plants during the growing season. Thus the farmer has better control over crop development, and he can utilize his materials, labor and equipment more efficiently.

Feed compounds, developed by industry, are making poultry flocks and livestock herds vastly more productive. Research on chemicals to control animal diseases and internal parasites is making great progress. Control of insect pests is already changing livestock management practices.

Du Pont *agricultural specialist Dr. Arne Carlson, M.S., '40, Ph.D., U. of Minnesota, '48, helps develop sprays and dusts to control fungous diseases.*

Phenothiazine *kills more kinds of livestock worms in more kinds of animals than any other drug . . . promotes normal growth.*

For growth insurance, *farmers treat seeds with disinfectants. "Ceresan" treated wheat gives up to 20% better yields.*



Spraying orchards *controls infestations of insects or plant diseases . . . or holds fruit on the trees until it is fully ready for picking!*

Turning ideas into products

Achievements such as these are the result of Du Pont's team research. An idea may start with one or two individuals. But many specialists—chemists, physicists, biologists, plant pathologists, and entomologists—must contribute their skills before a new product is ready for market. Normally, engineers—chemical, mechanical, civil, and electrical—develop the commercial processes and plants for making the finished products.

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Concrete Tying Devices

(*Continued from page* 16)

by virtue of its simple construction and coarse thread, 3½ to 6 threads per inch, may be used indefinitely with little depreciation. The versatility of strut wires in various shapes and sizes to the helix coil has made possible a family of products with a wide range of adaptability to conditions in the field of modern construction, from tying the simplest wall, anchoring and tying, and to support devices for form work.

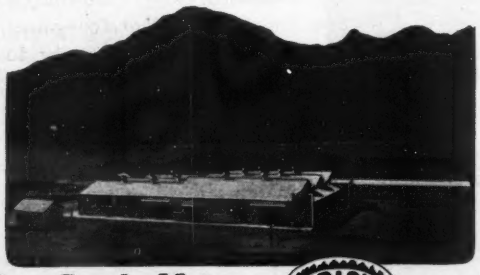
Advantages of Tyscru System

A few of the advantages of the Tyscru system are that they are applicable to any condition arising in tying and anchoring of concrete form work, they save up to two-thirds the amount of steel that is required for ordinary field assembled ties such as "Rods and Clamps" or "She-Bolts." The Tyscru system saves time since these ties are made to fit job conditions; cost is lowered because such a small percentage of the steel is left in the concrete after stripping the forms; and they may be easily and quickly used for reanchorage of form lifts because of the coarse threads.

The Tyscru itself is made of two or four wire struts that are electrically welded to two helix coils. This forms the interior portion of the tie which remains in the concrete. The exterior parts are the Tylags and Flat Washers. The Tylag is especially made from bolt finished stock or alloy steel. It has only 3½ to 6 threads per inch, according to bolt diameter, and has sufficient thread to furnish a variation of 6 inches in the wall thickness. The coarse thread feature prevents binding by the concrete and permits easy removal when stripping the forms. The Flat Washers are used against the outside of the wales to provide a bearing surface for the load taken by the Tylag. These washers are made to suitable dimensions from high strength steel.

Many states have specifications that require that all of the steel in concrete structures be kept back a certain number of inches from the face of the concrete. The Tyscrus are made in increments of ⅛ of an inch so as to provide for exact sizes in all cases. In order to insure that the ties are placed at the required distance from the face of the wall and remain there while the concrete is being poured, *Tycones* were introduced. The Tycones are made of malleable iron or wood without threads for a 1, 1½, or 2 inch setback of the tie ends. In addition to serving to keep the tie ends at the required setback, they also perform the function of a form spreader. In high thin walls this is very necessary as the forms tend to move out of alignment, resulting in warped forms. After stripping the forms the cones are removed, and since all of the steel of the tie is kept back from the face of the concrete, there is no necessity to cut the tie at the face of the concrete. This eliminates the troublesome problem of rust that had been so prevalent prior to the advent of the Tyscru. Upon removal of the cones there remains

(*Continued on page* 40)



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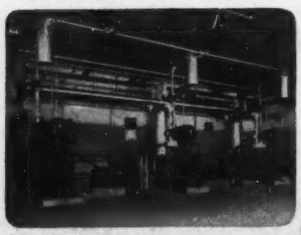

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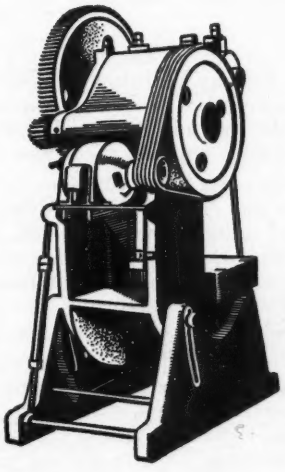

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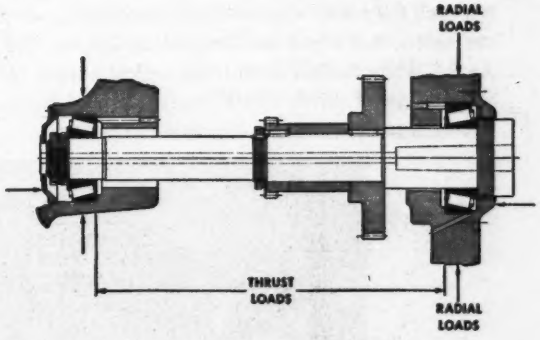

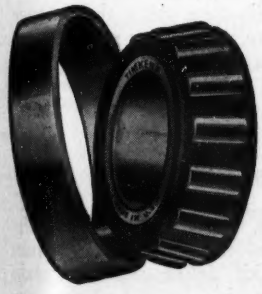

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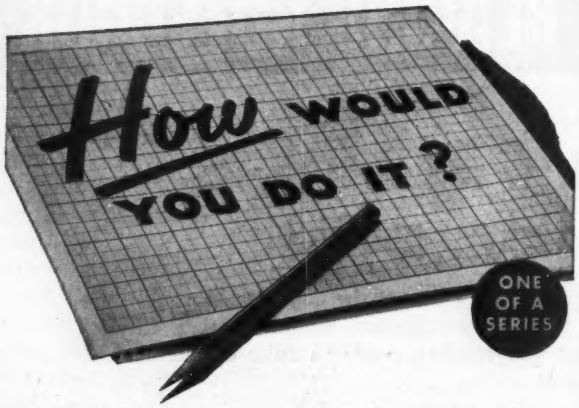

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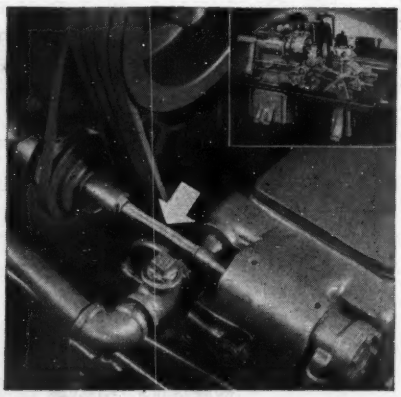
Photos courtesy of Gisholt Mach. Co. Madison, Wis.



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The Ethereal Medium

(*Continued from page* 12)

relating to the relative motion of ether and terrestrial objects.

Probably the most famous of such tests was the pioneer one made by Michelson and Morley in 1881. In 1905 the Michelson and Morley experiment was repeated by Morley and Miller with more sensitive apparatus, and same negative result was obtained.

During the years 1921 to 1925 an elaborate series of observations was carried out by Miller, the result of which seemed to indicate an ether drift with a velocity about one-third of the orbital motion of the earth. This drift, however, is not the result of the earth's orbital motion, but rather is considered (if a real effect) to be due to a "velocity of the solar system relative to stellar space" (Michelson).

John Robertson says in his "Physical Optics" that the weight of the evidence is decidedly in favor of the view that the existence of an ether cannot be proved by such experiments as Michelson's, and yet he feels Miller's results cannot be ignored.

Not only Robertson, but many other physicists, had concluded for years before Miller's disquieting results were announced that it is not possible to detect a motion of the earth with respect to an all-pervading ether.

King, previously referred to, is quite dogmatic in stating that it must be concluded that there is no ether and "those who continue to believe in the ether argue that nature may be so constituted as to conceal forever its existence. Since anything may be assumed to exist on the same basis, this is wishful, not scientific, thinking. Even engineers and physicists who are willing to agree that the ether is nonexistent and unnecessary, nevertheless continue to do all their electro-magnetic thinking and teaching in terms of Maxwellian pictures."

In his "Relativity and Space" Steinmetz held that it was merely conservatism or lack of courage which had prevented science from abandoning the ethereal hypothesis. He called attention to facts as hitherto mentioned that belief in an ether is in contradiction to the relativity theory of Einstein, since this theory holds that there is no absolute position or motion, but that all positions and motions are relative and equivalent. Thus, if science agreed that the theory of relativity is correct, the ether theory must be abandoned.

Relativity Forces Demise of Ether Theories

Scientists in general have, thereferoe, discarded the ether theory. They deride the radio ethereal medium as fiction, calling it a makeshift fabricated to explain something for which scientists have not had the correct explanation.

The possibility of a form of ethereal medium, however, remains far from the dodobird classification in the minds of many, as just discussed. Michelson was among the never-say-dies who cling to the hope "that the (relativity) theory may be reconciled with the existence of a medium, either by modifying the theory, or, more probably, by attributing the requisite properities to the ether."

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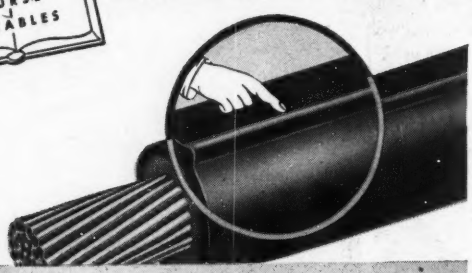

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THE CORNELL CO-OP

Barnes Hall — On The Campus

Concrete Tying Devices

(*Continued from page* 34)

only a small hole in the face of the concrete that may be easily grouted.

Figure 2 illustrates how the Tyscru is used as a tie and a spreader. The tie ends may be set back 1 to 2 inches from both finished wall surfaces by using unthreaded cones at the tie ends.

The adaptation of the Tyscru to battered walls is readily seen by examination of Figure 3.

Many times it is virtually impossible to ascertain in advance the exact sizes that will be required for a particular job due to the irregular, multiple battered walls of special wall form conditions. To cope with this situation the *Flex-Ty* based on the original Tyscru, was developed. Essentially the Flex-Ty is very similar to the Tyscru, the major difference being that it has a coil at one end only, instead of at both ends. (See Fig. 4). Installation of the Flex-Ty is accomplished in a manner much the same as that of the Tyscru. The coil end is placed at the required distance back from the plumb wall and secured by means of the Tylag and washer. The free ends or the ends without coils are passed through the rear of the form where they are secured on the wales by the Flex-Ty clamp. The Flex-Ty clamp is especially constructed with a hardened wedge-shaped bolt,. the head of which presses against the two wires when the nut is drawn up tight and grips the wire to full strength of the unit. Figure 4 shows the Flex-Ty unit assembled on a battered wall form.

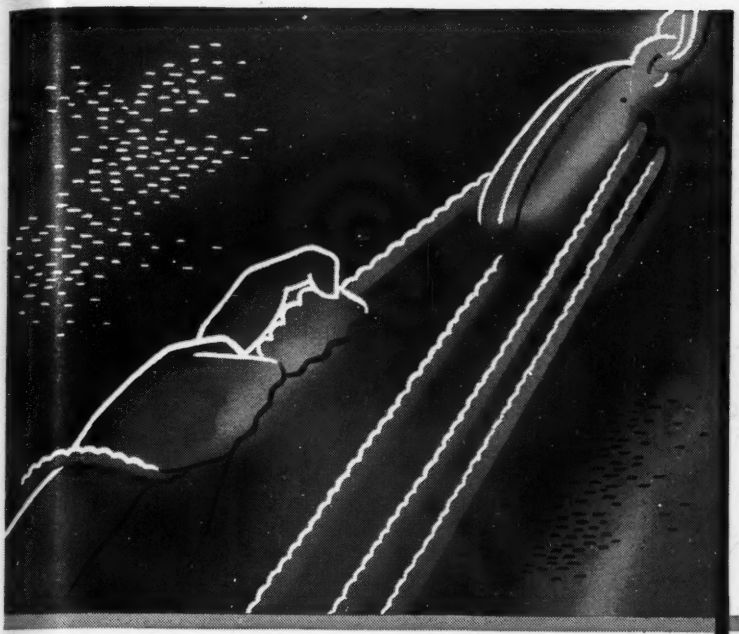
Table 1. Comparison between prefabricated and field assembled ties.

System	Tie	SafeLoad In Pounds	Tie Length In Inches	Weight Per Unit In Pounds	For 12" Concrete Wall and 5' Liquid Head: Wt. in Lbs. per Cu. Yd.	For 12" Concrete Wall and 5' Liquid Head: CostPer Cu. Yd.
Pre-fabricated	½" Tyscru	6000	10	3.28	11.07	$1.32
	½" Flex-Ty	6000	36	4.31	14.55	$1.90
Field Assembled	Band Iron	1500	36	1.25	16.88	$3.11
	½" Rod & Clamp	5000	36	5.62	22.76	$2.75

Potentialities of Flex-Ty

A striking example of the inherent potentialities of this tie in uncertain conditions are the highway bridges for the State of Pennsylvania. The Highway Department has established a set of standard plans for all of the highway bridges in the state, but due to the topo-

(*Concluded on page* 40)



When sail trimming is required

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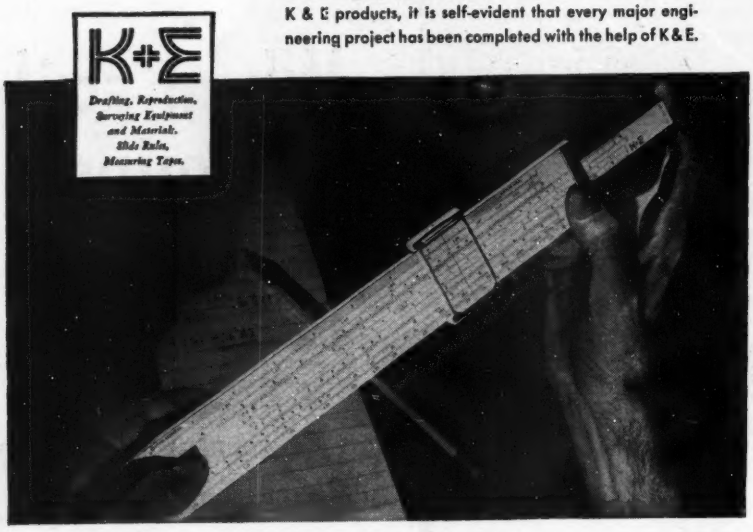

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Concrete Tying Devices

(*Continued from page* 40)

graphy at the site, it is necessary, at times, to make changes in the field. This occurs quite frequently in the construction of wingwalls. In order to solve this vexing problem, a large number of Flex-Tys are used, thereby eliminating the need for many different sizes. The exterior surface, upon stripping, is smooth and is not endangered by rust spots, whereas the rear surface is completely covered with backfill material.

Table 1 shows a comparison between the prefabricated and the field-assembled ties with respect to safe load, weight per unit, weight per cubic yard, and the cost per cubic yard.

In the final analysis, it is obvious that the prefabricated system is far superior to that of the field assembly, not only because of the fact that they are lighter, more easily installed, more efficient and adaptable to unusual conditions, but also from the economical point of view.

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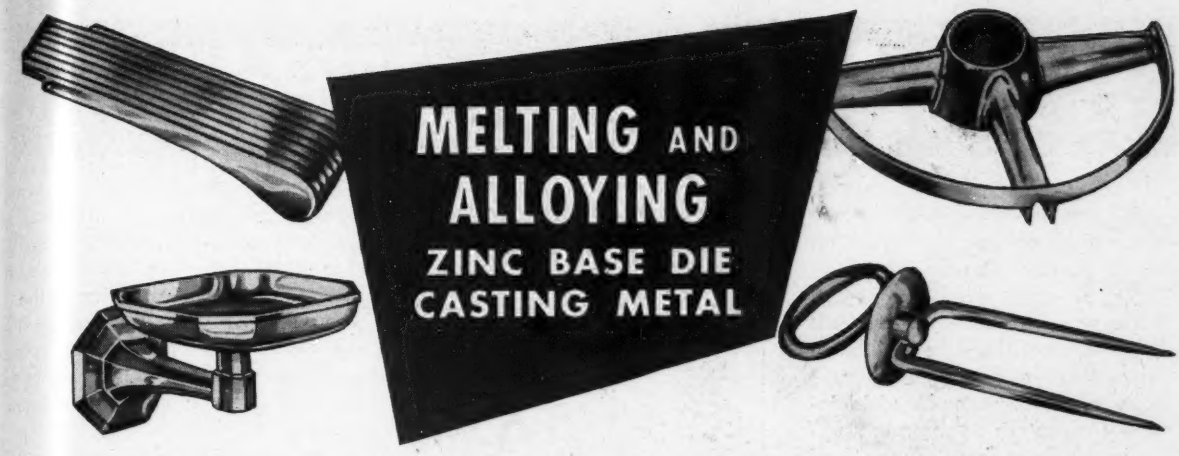

Reverberatory Furnace Operations

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Demonstrate High Temperature GAS Firing Technique

REVERBERATORY FURNACES designed to increase the production of zinc base die casting alloys have expanded melting and alloying capacity almost 50% over conventional pot melting. At Gerity-Michigan Corporation, Detroit, these Gas-fired furnaces operate on practically continuous schedules with savings of 35% to 40% based on time-saving methods and more efficient fuel utilization.

This application demonstrates the flexibility of GAS for industrial heating processes in high temperature ranges. But it also emphasizes the role of GAS in the development of production-line equipment for non-ferrous metals.

R. L. Wilcox, metallurgical engineer and Vice President of Gerity-Michigan Corporation describes the furnace and its application—"**This 18-ton Gas-fired reverberatory furnace has the advantage of extended service life, more efficient fuel utilization, closer temperature control, simplified alloy analysis.**"

Regardless of the type of heating operation or heat-treating process, GAS is the ideal fuel for any temperature requirement, or any production-line application. The characteristics of GAS—speed, flexibility, economy, controllability—are useful features for every industrial heating need. In view of rapid developments it's always worthwhile to keep your eye on what's new in Modern Gas Equipment.

Gas-fired reverberatory furnace designed and constructed especially for melting and alloying zinc base die casting alloys at Detroit Die Casting Division.

AMERICAN GAS ASSOCIATION

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STRESS and STRAIN...

The fine arts student from Morse Hall was explaining his inspiration to an EE from next-door Franklin.

"My friend," said the artist, "have you ever seen the lambent flame of dawn light up with awesome coloring the crashing sea? Have you ever seen the vivid intensity of nature as she mixes upon her palette the fiery gold of the sunset, the azure of the sky, the Stygian black of the night, the silver of the moon? Have you never seen this?"

"Well," ruminated the engineer, "not since I gave up drinking."

* * *

A Russian Wolfhound exiled in London, lunched with an English bulldog.

"Can't offer you much," said the bulldog. "Since the food shortage, Master even keeps the bone. How's Russia?"

"All the food we want," said the wolfhound. "Big chunks of meat! Juicy bones!"

"How come you're here, then?" asked the English dog.

"Well, a fellow likes to bark once in a while, doesn't he?"

* * *

"I can't get along with my wife. All she does is ignore me."

"Ignore you, eh?"

"Yes, and if there's anything I dislike, it's ignorance!"

* * *

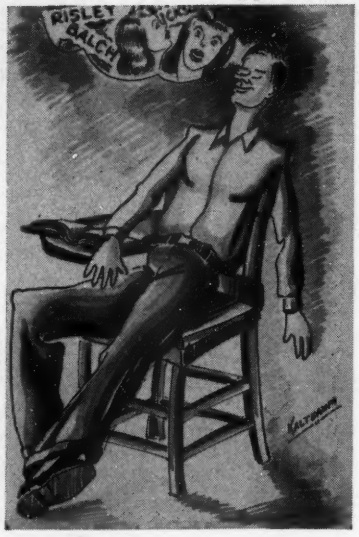
Sign in Baker Cafeteria: "If the steak is too tough for you, get out. This is no place for weaklings."

* * *

An Engineer who can drive safely while kissing a pretty girl isn't giving the kiss the attention it deserves.

* * *

All some girls know about cooking is how to bring a guy to a boil.



Fascinating lecture

"Pop, what makes world go 'round?"

"You little devil, stay out of that cellar!"

* * *

A professor, coming to one of his classes late, found a most uncomplimentary caricature of himself drawn on the blackboard. Turning to the student nearest him, he angrily inquired, "Do you know who is responsible for that atrocity?"

"No sir, I don't," replied the student, "but I strongly suspect its parents."

* * *

Believe it or not, the following two masterpieces are original!

MATHEMATICS

I think it is safe to state:
"There's nothing that one can't equate."
(Before you challenge, let me say,
One often has to use a "K".)

LIKE HELL, SON

Now, student, stop and think again
Equations fail—yes, even when
You use both K's and math complex,
A female being unknown X.

Lord Louis Sterling, the British-Gaumont executive, received word of his knighting while he was visiting America. To celebrate the occasion, friends tendered a banquet to him at the Astor, with everybody making flowery speeches that drew tremendous applause. But the show was stolen by the guest of honor's daughter, who cabled the new lord from London: "Congratulations, father —for making a lady out of mother!"

* * *

A farmer in our community was driving home one Saturday night last winter, well fortified against the cold. For purposes of maintaining this condition he had tucked his jug on the wagon seat and would refer to it from time to time as the horse jogged along. However, the horse slipped, sat down in the road, and refused to budge. Our farmer friend consulted his jug, then stepped down and butted the other end of the horse a couple of times, with no results. After another conference with the jug he walked around to the horse's head and tugged on the harness mightily, again with no result. With some disgust he climbed back on the wagon seat, once more hefted the jug, then regarded the horse with fire in his eye. "I'm giving you one more chance to git up," he shouted, "and then I'm goin' to drive right over you!"

* * *

1st Drunk: (encouragingly): "Shay, friend, why doncha take a shtreetcar home?"

2nd Drunk (sadly): "Sh'no use, pal, sh'no use. M'wife wouldn't let me keep it in the houshe.

* * *

"Porter, bring me another glass of ice water."

"Sorry, suh, but if I takes any mo' ice, dat co'pse in de baggage car ain't going to keep."